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LX10 Field Tripod!
Regularly $195, now free for a limited time!

MEADE LX10

MEADE LX10 EMC
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Meade 8" LX10 Schmidt-Cassegrain Telescope.
Complete as shown with equatorial wedge and hand controller and, for a limited time, with *free* LX10 Field Tripod:

$995

Buy a Meade 8" LX10 Schmidt-Cassegrain telescope for $995 and, for a limited time, receive the $195 LX10 Field Tripod absolutely FREE!

For the serious amateur astronomer on a more limited budget, or for the more casual observer who nonetheless demands the very finest in optical performance, the Meade 8" LX10 satisfies every requirement. *Standard-equipment includes:*

Super-Multi-Coated Optical System: The *exact same* multi-coated 8" Schmidt-Cassegrain optical tube assembly as the more expensive Meade 8" LX200.

Series 4000 Super Plössl 26mm eyepiece: An $80 eyepiece, the SP26mm complements the exquisite imaging of Meade 8" Schmidt-Cassegrain optics.

Equatorial Fork Mounting: The relatively light weight, but very stable, LX10 fork mounting provides all of the rigidity required for sensitive high-power visual applications of the telescope, or for photographic or CCD imaging.

Cordless, DC-Powered Electronic Motor Drive: With electronically-regulated DC servo motor for automatic *sidereal-rate* tracking; powered for 50 hours by four AA-size batteries that fit conveniently into the telescope's control panel.

Worm-Gear System: The LX10's 5.75"-diameter worm gear produces extremely smooth, regular motion in R.A., with low periodic error — a periodic error that permits such advanced capabilities as long-exposure astrophotography or CCD imaging.

Hand Controller: Essential for micro-guiding the telescope in R.A. at 2x speed during long-exposure astrophotography. With the optional electric Declination motor *(see below)* added to the telescope, the hand controller is functional at 2x speeds on both telescope axes.

LX10 Field Tripod: The chromed steel LX10 Field Tripod provides an extremely rigid platform for visual and photographic observations with the telescope. Regularly $195, this tripod is included **free of charge** for a limited time with your purchase of the 8" LX10 telescope. *This free offer is valid from January 15, 2001 until further notice at participating dealers in the U.S.A.*

SPECIFICATIONS: 8" Model LX10 — Includes 8" Schmidt-Cassegrain optical tube assembly with EMC super multi-coatings (D = 203mm; F = 2000mm, f/10); fork mount with setting circles, manual slow-motion controls, and locks on both axes; 5.75" LX worm gear reduction system; sidereal-rate electronically-regulated DC servo motor drive; 4- pushbutton hand controller for 2x speed corrections in R.A.; battery compartment accepting four (user-supplied) AA-size batteries (telescope may also be powered from an auto cigarette lighter plug, using optional 25 ft. cord); 6 x 30mm viewfinder; eyepiece-holder and diagonal prism (1.25"); SP26mm multi-coated eyepiece; standard equatorial wedge with elevation scale, fine elevation control, and 360° azimuth orientation capability; LX10 Field Tripod (included only for a limited time, as noted above); complete operating instructions.
$995. (+ $65 packing & shipping in the 48 states)

Electric Declination Motor System for LX10	**95.**
#2014 Magellan I Telescope Computer System for LX10 with 12,218-object database	**375.**

Prices shown are suggested U.S. mail-order prices.

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FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

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MEADE
LX200
MEADE LX200 EMC
Meade

The largest-selling serious telescopes in the world are now available at the most affordable prices *ever!*

With their large object databases, fast slewing speeds, and uncanny pointing precision, Meade LX200's are recommended for those amateurs who intend an extensive program of CCD imaging, astrophotography, or deep-space observing. Compare a Meade LX200 feature-for-feature with competing single-tine-fork, spur-gear-driven, GO TO Schmidt-Cassegrains:

Superb Optics: With oversize primary mirrors for greater full-field illumination, LX200 diffraction-limited imaging capabilities are a legend in the industry; we regularly receive reports stating that optical performance approaches that of a fine *ED* apochromatic lens.

Automatic GO TO Capability: Competing 8" Schmidt-Cassegrains claim to place objects "somewhere in the field of view"; Meade LX200's place objects **dead-center** in the field of view, first time, every time, to a pointing precision of **2 arc-minutes or better,** or, with Meade exclusive High Precision Pointing, to a precision of **one arc-minute or better.** *Meade LX200's are the only commercial telescopes ever manufactured that automatically GO TO any input R.A. and Dec., or to any object in the onboard database, to these levels of precision.*

Database of 64,359 Objects, a database *more than three times larger* than competing GO TO telescopes.

Permanently-Programmable Smart Drive™ routinely achieves 5 arc-sec. periodic error, an observatory standard. Other brands of GO TO 8" SCT's decline to state their periodic error and do not offer any programmable error-corrector.

9-Speed Dual-Axis Electronics: Electronics that cover every contingency of telescope positioning — from 2x photo-guide, to 32x image centering, to 8°/sec. slewing across the sky, plus 6 other dual-axis drive speeds in between.

Rigid LX200 Dual-Tine Fork Mountings with Dual 5.75" Worm Gears are the choice of advanced observers, CCD imagers, and astrophotographers for their most sensitive applications. Competing spur-gear-driven single-tine forks can not approach the strength, rigidity, and drive-rate precision built into every Meade LX200 mounting.

Full Long-Exposure Capability: Competing 8" GO TO telescopes describe their capability to take short-exposure "planetary and terrestrial photos," without reference to any long-exposure capabilities. Meade LX200's have been the instruments of choice in **thousands** of the most detailed long-exposure images ever taken by amateur astronomers.

Strong Field Tripods: Unlike the thin, extruded aluminum tripods of competing models, every LX200 includes a fully adjustable steel field tripod perfectly suited to the sub-arc-second resolution of the telescope's optics.

SPECIFICATIONS: 7", 8", 10", and 12" LX200's — Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 Schmidt-Cassegrain or 7" f/15 Maksutov-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function control panel; manual and electric slow-motion controls on both axes; keypad hand controller with digital readout display, permanently programmable Smart Drive, 9-speed drive controls on both axes (7-speed on 12"), High-Precision Pointing, and GO TO controller; 64,359-object onboard celestial software library; 25 ft. power cord and adapter for telescope operation from 115v.AC (optional #1812 Electronic DC Adapter allows for field powering directly from an automobile cigarette lighter plug); 8 x 50mm viewfinder; 1.25" diagonal prism (7", 8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (7", 8", 10") or giant field tripod (12"); operating instructions.

8" LX200 Schmidt-Cassegrain	**$2295**
10" LX200 Schmidt-Cassegrain	**2695**
12" LX200 Schmidt-Cassegrain	**3995**
7" LX200 Maksutov-Cassegrain	**2795**

Packing and shipping in the 48 states: 8"—$105; 10"—$145; 12"—$215; 7"—$125.

Prices shown are suggested U.S. mail-order retail prices.

Meade 8" LX200
Schmidt-Cassegrain
Telescope.
Complete as shown:

$2295

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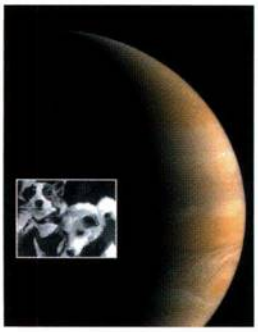

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COVER PHOTO: NASA/JPL; inset: Bettmann/CORBIS

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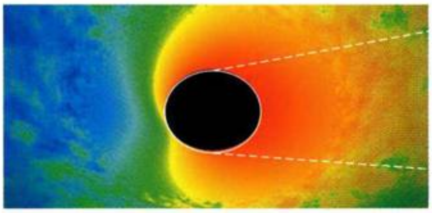

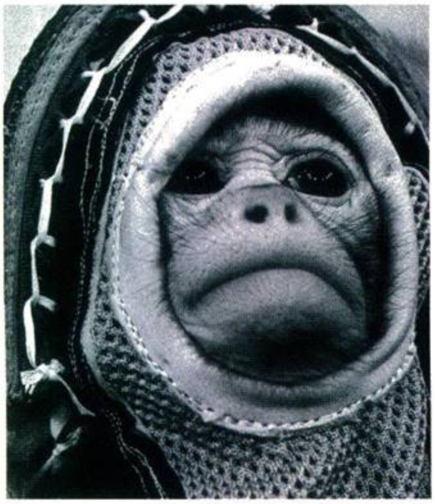

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BEHIND THE SCENES

BY BONNIE BILYEU GORDON

Dogs and Chimps in Space

On March 23, 1961, the Soviet Union sent the space capsule Vostok 3KA-2 into orbit. Last in a series of tests that would launch Yuri Gagarin into history, the capsule carried a small dog called Zverzdochka. In December 2000, that capsule was offered at public auction by the Ultimate Auctioneers of Fox Studios. A Fox spokesman suggests this capsule is the most historically significant spacecraft ever offered for sale.

Wishing to commemorate the lives of animal astronauts in another way, *Astronomy* is running a story to mark the anniversary of animal space flight. We chose this year to celebrate because the first "successful mission" took place 50 years ago. A success is one in which the animal returned to Earth alive, the first of which occurred in 1951 when a U.S. Aerobee rocket carried the monkey Yorick into space and home again. Prior missions failed at returning animals safely, but sent back research results. NASA refers to these missions as semi-successful.

Bettmann/CORBIS

Malyshka, a space dog in training, models its space suit and helmet in November 1957 for press in Moscow.

We are especially happy to share with you some rare photographs of a whole range of reluctant astronauts. You will find capsule biographies of many others by visiting astronomy.com. We had hundreds of images from which to select; these were tough choices.

Kelly Kizer Whitt wrote the history of animal space travelers (page 42). And to accompany the story of dogs and chimps in space, we include a charming portrait by Jim Schefter of the first human space traveler, Yuri Gagarin, who went into orbit 40 years ago (page 36).

Astronomy

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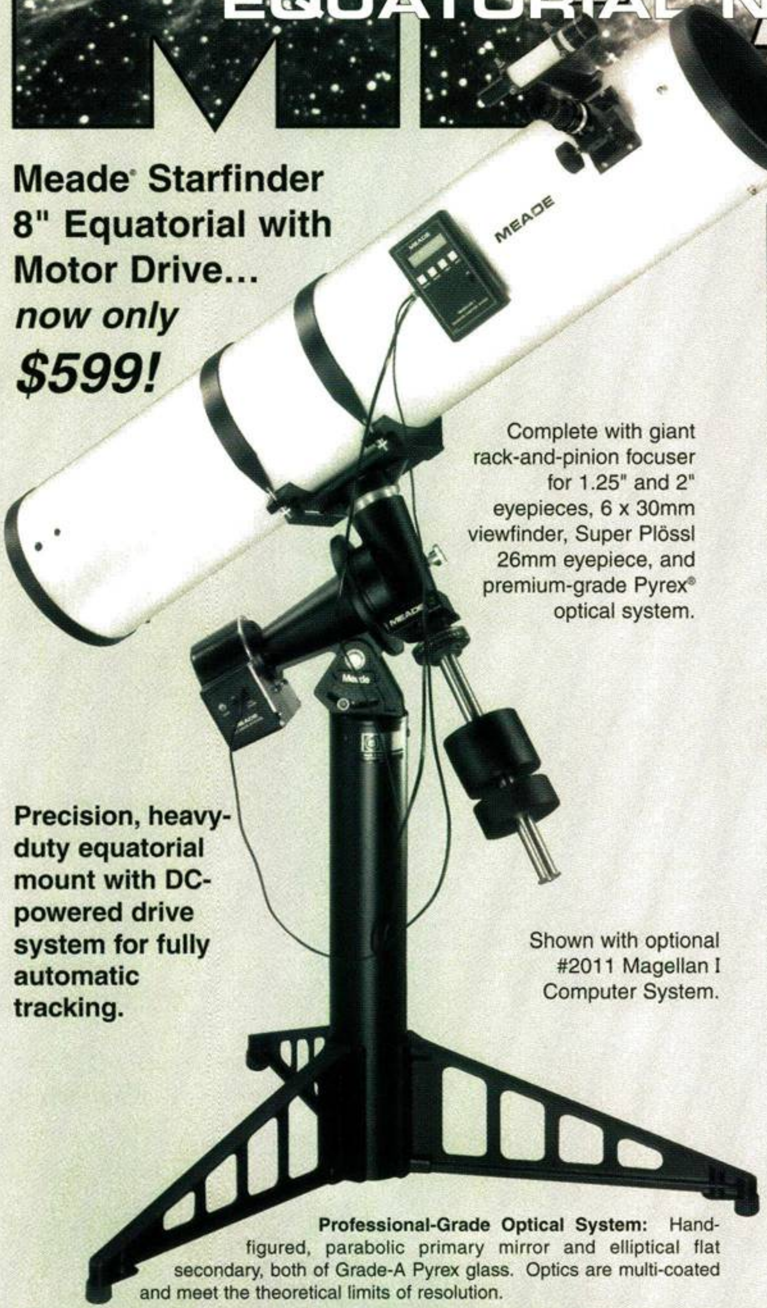

Meade® Starfinder 8" Equatorial with Motor Drive... *now only* ***$599!***

Complete with giant rack-and-pinion focuser for 1.25" and 2" eyepieces, 6 x 30mm viewfinder, Super Plössl 26mm eyepiece, and premium-grade Pyrex® optical system.

Precision, heavy-duty equatorial mount with DC-powered drive system for fully automatic tracking.

Shown with optional #2011 Magellan I Computer System.

Professional-Grade Optical System: Hand-figured, parabolic primary mirror and elliptical flat secondary, both of Grade-A Pyrex glass. Optics are multi-coated and meet the theoretical limits of resolution.

Accessories and Components: Premium-grade multi-coated SP26mm eyepiece (1.25"); 6 x 30mm viewfinder with wide 7° field; strong, durable, spiral-wound optical tube with attractive white finish.

Precision Equatorial Mount: Manufactured of machined aluminum to tolerances of .001" or better, with 4"-dia. pier and die-cast tripod legs for rock-solid support of the optical tube. Moves effortlessly from object to object on precision bearing surfaces. Polar and Dec. shafts are 1" solid steel. Setting circles on both axes.

Battery-Powered Cordless Drive System: For fully automatic tracking of celestial objects. Operates over 50 hours from 6 (user-supplied) AA-batteries or from 12v. auto cigarette lighter plug, using optional 25 ft. cord.

2" Giant Focuser: Meade #77 giant rack-and-pinion focuser is included as standard equipment, with eyepiece-holders for both 1.25" and 2" eyepieces.

Starfinder Equatorial 16: Includes equatorial mounting with 1.5" steel shafts, Sealmaster ball bearings, 6" dia. pier, and 6 x AA-size battery-powered worm gear drive; 8 x 50mm viewfinder; #77 giant focuser.

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MAGELLAN I
TELESCOPE COMPUTER SYSTEM

Magellan I Telescope Computer System: Use the Magellan I computer to manually slew the telescope quickly to any of 12,218 database objects, or to any object of known R.A. and Dec. Specifications and object database are identical to Magellan I for Starfinder Dobsonians *(see facing page)*.

#2011: for Meade Starfinder Equatorial 6", 8", or 10"	**$295.**
#2012: for Meade Starfinder Equatorial 16"	**295.**

MEADE
MAGELLAN II

Magellan II Computer-Corrector: Plug the Magellan II into the control panel of your Meade Starfinder Equatorial and you have all the capabilities of the Magellan I, above, including 12,218-object database, *plus* a 4-speed (2x, 8x, 16x, 32x), dual-axis, drive corrector/microslewing system.

#2018: for Starfinder Equatorial 6", 8", 10"	**495.**
#2019: for Starfinder Equatorial 16"	**595.**

Packing & shipping in the 48 states: Magellan I – $15, Magellan II – $20.

Special Eyepiece Offer! At the time you order any Meade Starfinder Equatorial telescope, you can buy a Meade Series 4000 Super Plössl 9.7mm eyepiece ***for only $29.95!*** *Purchased separately, the SP9.7mm eyepiece sells for $79.95.*

Meade Starfinder Equatorial Telescopes

6" f/8	**$499**	**10" f/4.5**	**699**
8" f/6	**599**	**16" f/4.5**	**2695**

Packing & UPS Shipping Charges to any address in the 48 states: 6"—$65; 8"—$75; 10"—$90; 16"—$55 packing, shipped truck freight collect.

To Order any Starfinder model: contact your authorized Meade Advanced Products Dealer. Prices shown are suggested U.S.A. mail-order retail prices.

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Free #882 Field Tripod!
Regularly $99, now *free* for a limited time

Now you can join the ETX revolution for as little as $299, complete!

Let Meade high-resolution ETX optics and standard-equipment Autostar controller take you on an automated guided tour of the Solar System, the Galaxy, and beyond.

Fork Mount with Dual-Axis Drive System: Precision worm gear systems permit smooth pushbutton motions of the telescope, as well as sidereal-rate tracking in the altazimuth mode.

Free #882 Field Tripod!

For a limited time you can purchase a Meade ETX-60AT or ETX-70AT Astro Telescope and receive a full-length Meade #882 Standard Field Tripod (regularly $99), **absolutely free.** The #882 Tripod is ideal for either seated or standing observations through the telescope. *This offer is valid from January 15, 2001, until further notice, at participating Meade dealers in the U.S.A.*

Standard-Equipment #494 Autostar™ Controller: Includes most of the same features as the more advanced #497 Autostar available for larger ETX models *(facing page).*

- **Automatic dual-axis GO TO function at 4.5°/sec.** to any of more than 1450 database objects, including the complete Messier and Caldwell deep-space object catalogs, the major planets from Mercury to Neptune, 26 asteroids, 15 periodic comets, and more. Or GO TO *any* object of known R.A. and Dec.
- **9-speed Dual-Axis Operation:** Pushbutton control of the telescope on both axes, simultaneously, at any speed from 2x sidereal to 4.5°/sec., plus sidereal-rate tracking.

High-Resolution Achromatic Objective Lenses of exclusive Meade design; each lens yields razor-sharp images of astronomical and terrestrial subjects.

Flip-Mirror System: Flip the internal optical flat mirror "up" for 90° observing; flip the mirror "down" for terrestrial observing with the optional #933 45° Erecting Prism or for *photography* with the optional #64ST Photo Adapter.

Cordless Operation: The dual-axis drive operates for over 20 hours in the field from six AA-size (user-supplied) batteries which store neatly inside the drive base.

MEADE ETX-60AT • ETX-70AT

Solar System
Saturn
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GO TO
MEADE
AUTOSTAR
Guided Tour
Tonight's Best
ENTER
MODE
GO TO
MEADE
AUTOSTAR
MEADE
COMPUTER CONTROL

ETX-70AT: $349, complete with #494 Autostar Controller and #882 Standard Field Tripod

ETX-60AT: $299, complete with #494 Autostar Controller and #882 Standard Field Tripod

SPECIFICATIONS: ETX-60AT and ETX-70AT Astro Telescopes — Each includes achromatic refractor optical tube assembly (D = 60mm, F = 350mm, f/5.8 *or* D = 70mm, F = 350mm, f/5) with multi-layer optical coatings; internal flip-mirror system for either straight-through or 90° observing position; fork mount with electric slow-motion controls, setting circles, and locks on both axes; electronic control panel; 9-speed (2x sidereal through 4.5°/sec.) dual-axis motor drive system with #494 Autostar computer controller; sidereal-rate tracking; internal compartment accepting six (user-supplied) AA-size batteries; MA9mm (39X) and MA25mm (14X) multi-coated eyepieces; #882 Standard Field Tripod (included only for a limited time, as noted above); operating instructions. **ETX-60AT — $299** (+$10 packing & shipping in the 48 states); **ETX-70AT — $349** (+$10 P & S).

OPTIONAL SYSTEMS FOR MEADE ETX TELESCOPES*

#882 Standard Field Tripod (60, 70)	$99.00	#883 Deluxe Field Tripod (90, 125)	199.95
#827 8 x 25mm Right-Angle Viewfinder (60, 70)	49.95	#825 8 x 25mm Right-Angle Viewfinder (90)	49.95
#773 Hard Carry Case (60, 70)	59.95	#774 Hard Carry Case (90)	99.95
#933 45° Erecting Prism (60, 70)	49.95	#775 Hard Carry Case (125)	149.95
#64ST Photo Adapter (60, 70)	19.95	*#932 45° Erecting Prism (90, 125)*	49.95
#497 Autostar Computer Controller (90, 125)	149.00	#64 Photo Adapter (90, 125)	34.95
#880 Equatorial Table Tripod (90)	29.95	Electric Focuser #1244 (90) *or* #1247 (125)	119.95
#881 Equatorial Table Tripod (125)	59.95		

**see also the Meade accessory ad in this issue.*

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ETX-90EC · ETX-125EC

Save up to $150!
ETX-90EC now $495
Autostar $99 for a limited time!

ETX-90EC: **$495**, complete with Electronic Controller

ETX-125EC: **$895**, complete with Electronic Controller

Meade® 3.5" and 5" ETX® models include the very latest in microprocessor-controlled capability:

Fork Mount with Dual-Axis Drive System: Each with high-torque DC motors on both telescope axes, permitting electronic operation from the standard-equipment plug-in hand controller.

Pushbutton Electronic Hand Controller: Use any of four dual-axis speeds: 8x for image centering at high power; 32x for image centering at lower power; 0.75°/sec for image centering in the viewfinder or for terrestrial tracking; 5°/sec for fast slewing across the sky.

Maksutov-Cassegrain Optical Systems: Manufactured at the Meade Irvine, facility, ETX diffraction-limited optics produce images so high in contrast and resolution that ETX telescopes often outperform other telescopes of larger apertures.

Flip-Mirror System: Flip the internal optical flat mirror "up" for 90° observing; flip the mirror "down" for terrestrial observing with the optional #932 45° Erecting Prism or for photography with the optional #64 Photo Adapter.

Cordless Operation: The dual-axis drive system operates for more than 40 hours from eight (user-supplied) AA batteries which store neatly inside the drive base.

Special Offer: ETX-90EC now $495!

Now for a limited time you can purchase the Meade ETX-90EC Astro Telescope — the largest-selling modern telescope in the world — at $495, a savings of $100 off the regular price. *This offer is valid from January 15, 2001, until further notice, at participating Meade dealers in the U.S.A.*

Optional #497 Autostar™ Now Only $99 (regularly $149) For a Limited Time! Plug in the optional Meade #497 Autostar computer controller for LX200-type operation, including:

- **Automatic dual-axis GO TO function at 5°/sec** to any of more than 14,000 database objects, including thousands of deep-space objects; the 8 major planets from Mercury to Pluto; 26 of the brightest asteroids; 15 periodic comets; and more.
- Select any of Autostar's database objects, or any object of known R.A. and Dec, press ***GO TO*** and the telescope automatically slews to the object.
- **9-Speed Dual-Axis Operation:** Pushbutton control of the telescope on both axes, simultaneously, at any speed from 2x sidereal to 5°/sec., plus sidereal-rate tracking.

SPECIFICATIONS: ETX 90EC and ETX-125EC Astro Telescopes — Each includes Maksutov-Cassegrain optical tube assembly (D = 90mm, F = 1250mm, f/13.8 *or* D = 127mm, F = 1900mm, f/15) with EMC super multi-coatings; internal flip-mirror system for either straight-through or 90° observing position; fork mount with electric slow-motion controls, setting circles and locks on both axes; electronic control panel; 4-speed (8x, 32x, 0.75°/sec, 5°/sec) dual-axis motor drive system with hand controller; sidereal-rate tracking in equatorial mode with optional table tripod or deluxe field tripod; internal battery compartment accepting eight (user-supplied) AA-size batteries; 8 x 21mm erect-image (ETX-90EC) *or* 8 x 25mm right-angle (ETX-125EC) viewfinder; Series 4000 Super Plössl 26mm eyepiece (1.25"); instructions. **ETX-90EC — $495** (+ $20 packing & shipping in the 48 states); **ETX-125EC — $895** (+ $30 P & S).

AUTHORIZED U.S. AND CANADA MAIL-ORDER DEALERS

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 925-447-9570.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
Orders & Information: 800-483-6287.

POCONO MOUNTAIN OPTICS, Moscow, PA.
Orders: 800-569-4323; Info.: 570-842-1500.

RIVERS CAMERA, Dover, NH.
Orders: 800-245-7963; Info.: 603-742-4888.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders & Info.: 800-621-2248; IL: 847-367-4600.

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

6001 Oak Canyon, Irvine, CA 92618. (949) 451-1450. FAX: (949) 451-1460. www.meade.com

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RESEARCH-GRADE ACCESSORIES

Series 4000™ Super Plössls
52° field; multi-coated

Meade 4-element Super Plössls, updated and redesigned to utilize the latest in optical glass-types, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or for deep-space; guaranteed to deliver more contrast and image sharpness than any other brand. Rubber eyeguards fold down for eyeglass wearers–a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm	each:	**$79.95** (4.54)
32mm (52°); **40mm** (44°)	each:	**99.95** (5.26)
56mm (52°; 2")		**199.95** (7.02)

Series 4000™
2x Apochromatic Barlow Lens

#140: The most advanced Barlow lens available for commercial telescopes, the Meade #140 includes 3-element, multi-coated, air-spaced optics. Doubles the power of any eyepiece with which it is used and yields images absolutely unmatched in resolution, contrast and color correction. The #140 optically complements any telescope — refractor, reflector, or Schmidt-Cassegrain. Accepts 1.25" eyepieces. Mechanical components are of machined aluminum and brass. Lens diameter is 28mm; clear aperture 26mm.

$79.95 (5.26)

Series 4000™
Super Wide Angle
67° field; multi-coated

For exquisite wide-angle images at low-to-medium powers, with pinpoint edge-of-field resolution. Ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8mm, 18mm, and 24.5mm are superb complements to the #140 Barlow, above.

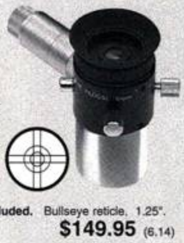
Super Wide Angle (SWA; 6-elements; 1.25"; 67°)–**13.8mm: $139.95** (4.54); **18mm: 149.95** (4.54); **24.5mm: 179.95** (5.26); **32mm** (2"): **239.95** (7.02); **40mm** (2"): **299.95** (7.02)

Series 4000™
Ultra Wide Angle
84° field;
multi-coated

The ultimate eyepieces; extreme image sharpness over an amazing 84° field. A perfect optical match with Schmidt-Cassegrains and fast Newtonians.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)– **4.7mm: $169.95** (5.26); **6.7mm: 199.95** (5.26); **8.8mm** (1.25"/2"): **239.95** (7.02); **14mm** (1.25"/2"): **299.95** (7.02)

World's Most Advanced Illuminated Reticle Eyepiece



Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Multi-coated optics. **Internal batteries included.** Bullseye reticle, 1.25".

$149.95 (6.14)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

$129.95 (5.26)

Series 4000 Photo-Visual Color Filters (1.25")–Premium filters, made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue

each **$14.95** (2.73)

Set #1–4 filters: #12, #23A, #58, #80A	**49.95** (4.54)
Set #2–4 filters: #11, #25A, #47, #82A	**49.95** (4.54)
Set #3–4 filters: #8, #21, #38A, #56	**49.95** (4.54)

Series 4000 Moon Filter (#ND96): Reduces glare and irradiation during lunar observing. 13% uniform light transmission across the visual spectrum. Threads into 1.25" barrels. **$16.95** (2.73)

Series 3000™ Plössls
50° field; multi-coated

Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Focal lengths from 5mm through 25mm are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. All eyepieces are fitted with fold-down rubber eyecups for comfortable observing. The PL40mm *(far right in photo)*, an excellent complement to any ocular set, produces spectacular low-power, wide fields, ideal for scanning the Milky Way. Manufactured exclusively to Meade optical designs, Series 3000 Plössls yield fine, high-resolution results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$49.95** (3.86); **40mm** (44° field): **$79.95** (3.86)

Series 4000™
f/6.3 Focal Reducer/ Field Flattener

f/6.3 FOCAL REDUCER/FIELD

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCT's to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5" at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture. **$129.95** (5.26)

#911B
#910B
#908B

#911N
#910N
#908N

Series 4000 Nebular Filters—Premium multi-layer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high-contrast observing of faint nebulae.

#908B–Threads into 1.25" eyepieces, 26mm dia.	**79.95** (4.54)
#910B–Threads into 2" eyepieces, 44mm dia.	**119.95** (5.26)
#911B–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**99.95** (5.26)
#908N–Threads into 1.25" eyepieces, 26mm dia.	**89.95** (4.54)
#910N–Threads into 2" eyepieces, 44mm dia.	**129.95** (5.26)
#911N–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**119.95** (5.26)

#911X
#910X
#908X

Series 4000 Oxygen-III Filters Observe diffuse emission and planetary nebulae as you never thought possible! Exclusive Meade *60-layer* interference coating technology isolates the 496nm and 501nm O-III lines to tremendously enhance observable nebular structural detail in all telescopes.

#908X–Threads into 1.25" eyepieces, 26mm dia.	**99.95** (4.54)
#910X–Threads into 2" eyepieces, 44mm dia.	**159.95** (5.26)
#911X–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**149.95** (5.26)

2x Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"

$47.95 (4.54)

#905 Variable Polarizer (1.25")

For glare reduction in observing the Moon. Includes two Polarizer filters mounted in a machined cell and permits continuously variable light transmission from 5% to 25%, to compensate for varying lunar surface brightness according to the Moon's phase and the aperture of the telescope. Accepts 1.25" eyepieces. **$49.95** (5.26)

2x Short-Focus Barlow (1.25")

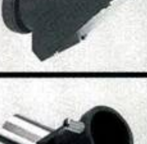
#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated. **$47.95** (4.54)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25".

$59.95 (4.54)

2" Diagonal Mirror



#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter. **#930:** Same as #929 but with 2" barrel to fit into focusers with 2" eyepiece-holders.

#929 or **#930,** each: **$99.95** (6.85)

45° Erecting Prisms

Fully coated roof prisms to invert the astronomical image in Schmidt-Cassegrains or refractors during terrestrial observations, while presenting a convenient 45° observing angle. Specify **#927** (.965"), **#928** (1.25"), or **#931** (fits .965" focuser, accepts 1.25" eyepieces).

$42.95 (3.86)

Electric Focusers for SCT's

For extremely smooth microfocusing of the image. Does not affect use of the manual coarse-focus knob.

#1206 Electric Focuser: Plugs into control panel of Meade 8", 10", 12" LX200 models and operates from LX200 hand controller. **$149.95** (7.48)

#1205 Electric Focuser: For **all** other Meade 8", 10", 12" SCT models; includes separate hand controller; accepts one self-contained (user-supplied) 9v. battery.

$169.95 (7.88)

#777 Off-Axis Guider for SCT's

Internal prism diverts light for monitoring telescopic image during long-exposure astrophotography. Threads to any Meade or Celestron rear cell. Use with illuminated reticle eyepiece and T-Mount for your 35mm camera.

$79.95 (6.85)

Modified Achromatic Eyepieces

Meade 3-element MA eyepieces yield sharp, well-corrected images on the Moon, planets, and deep-space at a reasonable price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. **MA 9, 12, 25, 40mm.**

each: **$37.95** (4.54)

MA12mm Illuminated Reticle Eyepiece

Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle; rubber eyecup. Wireless red LED illuminator and variable brightness control. 1.25". **Batteries included.**

$99.95 (3.45)

As above but with 6 ft. cord and plug for Meade telescopes with power panels, in place of wireless illuminator. **$79.95** (5.26)

Camera Adapters

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.

.965": **$27.95**; 1.25": **$29.95** (3.86)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-mount for your camera.

$39.95 (3.86)

Variable Tele-Extender

For eyepiece-projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Sliding cell with lock permits wide range of projection magnifications with the same eyepiece. Use with T-mount for your camera.

$39.95 (3.86)

T-Adapters for SCT's

Rigidly couples camera to telescope for prime focus photography with any Meade or Celestron Schmidt-Cassegrain. Use with T-Mount for your 35mm camera.

$26.95 (3.86)

CCD-Photo-Visual Flip-Mirror Systems

An essential accessory for imaging with ***any*** brand of CCD imager or for astrophotography with a 35mm camera. Flip mirror "down" to center the image while viewing with an eyepiece at 90°; flip mirror "up" to pass light on to CCD chip or 35mm camera film plane. Each unit includes: precision optical-flat Pyrex® mirror; 2-axis mirror-adjustment screws and locks for precise image centering; extra-fine helicoid focusing of the eyepiece; extension tubes for attaching either 35mm camera (using T-Mount) or CCD imager (using either T-threads or 1.25" barrel). Threads to rear cells of all Schmidt-Cassegrain telescopes; may remain on telescope and used in place of diagonal prism for visual observing as well.

"Over the past 10 years I have used all manner of flip-mirrors. The Meade Flip-Mirror Systems are absolutely the best—rock solid, high-precision, beautifully manufactured; they virtually eliminate all flexture between the CCD and telescope." — Jack Newton

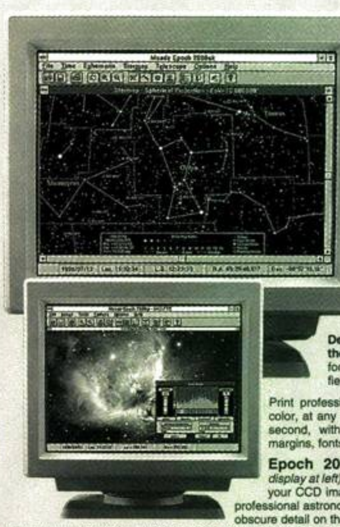
#644 Flip-Mirror System: Accepts any 1.25" eyepiece. Mirror clear aperture: 22mm. Use with CCD's up to Pictor 416XT or ST-7, or smaller; or visual observing with 1.25" eyepieces. **$149.95** (7.02)

#647 Flip-Mirror System: Accepts either 1.25" or 2" eyepieces. Mirror clear aperture: 40mm. Recommended for full-field 35mm astrophotography or with CCD's of any size, including all Meade Pictor Series through 1616XT, as well as ST-4 through ST-8; or for visual applications with 1.25" or 2" eyepieces. **249.95** (8.49)

#157 1.25" Adapter: Permits use of either Flip-Mirror on telescopes with 1.25" eyepiece-holders. (Requires approx. 2" additional focus travel with #644, 3" with #647.) **15.00** (3.86)

#644
MEADE
FLIP-MIRROR SYSTEM

#647
MEADE
FLIP-MIRROR SYSTEM



Epoch 2000® Sky Software

The most powerful astronomical software ever made available can now be yours for only $149!

Epoch 2000sk *(upper display at left):* Now you can use the most advanced, most precise full-color sky software ever created, to zoom-in on telescopic fields **smaller than one arc second!** With star positions displayed as precisely as **0.01 arc second,** the Trapezium in Orion is no longer shown as a single point, as in other software, **but as four precisely oriented starpoints, just as they appear in the telescope.** No longer do you need to guess the R.A. and Dec. of an object located away from the field center, as in other programs: Epoch 2000sk dynamically reads out the R.A. and Dec. of the cursor position anywhere in the field **and updates R.A. and Dec. instantaneously as the cursor is moved about the field.** Meade LX200 owners can use Epoch 2000sk for remote auto-centering of objects in the telescopic field **to a precision of 30 arc seconds,** routinely!

Print professional-quality star charts in either black-and-white or color, at any zoom setting or sky scale between 180° and one arc second, with your own customized borders, headers, footers, margins, fonts, colors, and grids.

Epoch 2000ip Image Processing Software *(lower display at left)*: Epoch 2000ip makes it easy to enhance and analyze your CCD images with the same sophisticated techniques used by professional astronomers to uncover hidden structure in a spiral galaxy or obscure detail on the surface of a planet. This powerful software includes virtually every technique available for image enhancement. Techniques that bring out detail totally invisible in your original image, transforming it from the ordinary to the spectacular.

EPOCH 2000sk Sky Software: 281,000 objects supplied on 3.5" discs for Windows 3.1 or higher; fully compatible with Windows 95 . . . . **$149**

EPOCH 2000sk-CD Sky Software: 19 million objects, including the complete Hubble Guide Star Catalog; supplied on CD-ROM **179**

LX200 Interface Cable: for Meade LX200 operation by Epoch 2000sk **25**

EPOCH 2000ip Image Processing Software: Supplied on 3.5" discs for Windows 3.1 or higher; fully compatible with Windows 95 . . . . **$199**

f/3.3 CCD FOCAL REDUCER

Series 4000™ f/3.3 CCD Focal Reducer/Field Flattener

NEW!

Revolutionary 3-element Meade design permits ultrafast CCD imaging with **increased** edge-of-field resolution and color correction! Reduces CCD exposure times by up to 80%. Threads on to the rear cell of any Meade or Celestron Schmidt-Cassegrain. Converts f/10 Schmidt-Cassegrain telescopes to **f/3.3** and f/6.3 SCT's to **f/2.** Variable T-Adapter (included) allows range of f/ratios between f/3 and f/5 on f/10 SCT's and between f/1.9 and f/3.2 on f/6.3 SCT's. Use with CCD imagers of any brand and chip dimensions. Not for visual or photographic applications. Multi-coated; 41mm clear aperture. **$149.95** (5.26)

Plössl 25mm Illuminated Reticle CCD Framing Ocular

NEW!
MEADE
PLÖSSL
CCD FRAMING

Displays rectangular frames of all popular CCD chip sizes, including all Meade Pictor models and ST-4 through ST-8. Shows precisely the image size and orientation that appear on CCD chip. Insert directly into telescope eyepiece-holder, or use with Flip-Mirror *(above).* Includes 4-element coated Plössl optics; lockable spacer ring to fix focus position; rubber eyecup; variable LED illumination control; batteries. 1.25". **$129.95** (4.54)

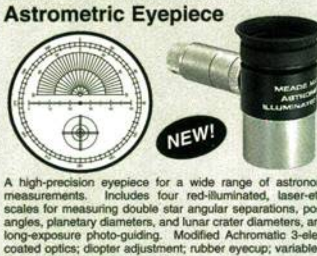
#825 8 x 25mm Right-Angle Viewfinder for ETX-90

Permits comfortable right-angle viewing. Replaces standard-equipment finder on 90mm ETX models, using the same bracket. Wide-angle, achromatic, coated optics; actual field 7.5°. Precise helicoid focusing. **$49.95** (4.26)

#64 T-Adapter for ETX®

Threads to the photo port of all ETX-90 and ETX-125 models. Rigidly couples any 35mm camera with removable lens to the telescope for lunar, planetary, or terrestrial photography. Includes extension tube for longer effective focal length, if desired. Use with T-Mount for your 35mm camera. **$34.95** (3.86)

MA12mm Illuminated Reticle Astrometric Eyepiece



A high-precision eyepiece for a wide range of astronomical measurements. Includes four red-illuminated, laser-etched scales for measuring double star angular separations, position angles, planetary diameters, and lunar crater diameters, and for long-exposure photo-guiding. Modified Achromatic 3-element coated optics; diopter adjustment; rubber eyecup; variable LED illumination control; batteries. 1.25". **$119.95** (4.26)

Series 4000™ 8mm – 24mm Zoom Eyepiece

NEW!

The finest zoom eyepiece available. High-resolution 7-element multi-coated optics, with 55° field at 8mm. Graduated scale in 1mm units indicates exact focal length in use. High-eyepoint yields comfortable observing even with eyeglasses. Internal zoom lenses move on the smoothest, most precisely-machined tracks yet developed for zoom optics. Performance is fully consistent with the finest fixed-focal length eyepieces. Threaded for filters; rubber eyecup; 1.25". **$219.95** (6.38)

ETX® Hard Carrying Cases

For secure storage or travel with your ETX. Thick-wall construction and die-cut foam lining. Accepts telescope, plus optional eyepieces, erecting prism, table tripod, hand controller, *etc.* Includes two steel latches with key.

#774 Case for ETX-90 models: **99.95** (8.58)

#775 for ETX-125EC: **149.95** (13.38)

#932 45° Erecting Prism for ETX®

For terrestrial observing with any ETX-90 or ETX-125 model. Yields correctly oriented image and convenient 45° observing angle. Threads to ETX rear cell. Accepts any 1.25" eyepieces. Coated roof prism optics. **$49.95** (3.86)

Advanced Field Tripod for ETX-125

#887: Yields *rock-solid* stability for sensitive applications of the ETX-125, even at high magnifications. **Includes fixed-height tripod convenient for standing observations, equatorial wedge with alignment controls in azimuth and latitude angle, and #889 Tripod Adapter for ETX-125.** Permits either altazimuth or equatorial orientation of the telescope for astronomical or terrestrial observing. Tripod legs are 2"-diameter chromed steel. For field use the tripod collapses for easy transport. **$349.95** (14.00)

Tripod Adapter for ETX-125

Included with the #887 Tripod *(above)*, the #889 Adapter is available separately and permits attachment of ETX-125 directly to any Meade LX10, LX50, or LX200 Schmidt-Cassegrain Field Tripod for altazimuth observing or to any Meade Schmidt-Cassegrain Tripod-with-Equatorial Wedge or Superwedge for equatorial applications.

#889 Adapter: **$69.95** (7.70)

ETX® Deluxe Field Tripod

#883: Custom-designed by Meade specifically for ETX-90 and ETX-125 Astro Telescopes. Tripod height adjusts from 34" to 54", for seated or standing observations. Micrometric controls in azimuth and elevation permit precise polar alignment of the ETX fork mount. Tripod head tilts and locks to 90° for terrestrial applications. Telescope attaches to tripod in seconds with 2 thumbscrews. All-aluminum construction. **$199.95** (10.00)

ETX® Carry Bag

Soft-padded Cordura-type carry bag with shoulder strap; permits storage of any 90mm ETX model, plus table tripod legs, eyepieces, other accessories. **$36.95** (5.26)

NEW!

Electric Focusers for ETX®

ELECTRONIC CONTROLLER
MEADE

Meade-engineered for smooth, rapid focusing with any ETX model. Four-speed operation from coarse to microfine. Standard-equipment hand controller accepts one 9v. (user-supplied) battery and focuses all ETX telescopes. Or focus ETX/EC models through the telescope's hand controller.

#1244 Electric Focuser for all ETX-90 models: **$119.95** (6.85)

#1247 Electric Focuser for ETX-125 models: **$119.95** (6.85)

HOW TO ORDER

Prices shown are suggested U.S.A. mail-order retail prices and do not include any applicable sales taxes. Suggested shipping and handling charges to the 48 states by U.P.S. or U.S. Mail shown in ( ) next to each price. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 925-447-9570.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
Orders & Information: 800-483-6287.

POCONO MOUNTAIN OPTICS, Moscow, PA.
Orders: 800-569-4323; Info.: 570-842-1500.

RIVERS CAMERA, Dover, NH.
Orders: 800-245-7963; Info.: 603-742-4888.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders & Info.: 800-621-2248; IL: 847-367-4600.

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EFSTONSCIENCE, Toronto, Ontario.
Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

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THIS IS WHAT HAPPENS WHEN YOU TELL YOUR ENGINEERS THE SKY'S THE LIMIT.

CELESTRON
CELESTRON

GPS
GLOBAL POSITIONING SYSTEM

They create the powerful, new NexStar® 11 GPS, which features technology never before found in a telescope. Practical technology like a Global Positioning System that will pinpoint your exact coordinates anywhere on earth. And the built-in digital compass, which quickly locates North for you, so your set up to star gaze becomes completely automatic.

Also new is our advanced Tour Function search engine with **over 40,000** objects in its database, including the complete RNGC, Messier, Caldwell, IC, Abell, selected SAO, planets, moon, and others. That's 10% more than any other telescope has, with future upgrades available on-line. Plus the computerized database can store the coordinates of numerous objects that you define.

Not only is the NexStar® 11 GPS quick to set up and easy to use, but the accuracy of this new technology is already winning rave reviews. In recent reviews the editors stated, ***"Our pointing tests with NexStar gave us perfect results every time."***

Perfect results every time. What more do you need to know?

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How about that NexStar® 11 GPS has **21% more light gathering power** than competitive 10" models. Or that the NexStar® 11 GPS is the first commercial telescope to incorporate a feature to prevent cord wrap, possible because all power comes through a non-moving drive base.

The NexStar® 11 GPS is also the only commercial telescope that has a **carbon fiber optical tube.** This aptly dubbed space-age material is lightweight, incredibly durable and has lower thermal expansion than aluminum and other metals. Making it perfect for the job at hand.

Each optical element in the NexStar® 11 GPS is individually hand figured and guaranteed to be diffraction-limited. Incredibly, Celestron is the only large commercial telescope builder to employ hand figuring – a complex optical procedure where ultra smooth corrections are made to the secondary mirror to ensure consistently high quality. Additionally, the primary and secondary mirrors have Starbright™ coatings applied for maximum reflectivity, with anti-reflection coatings on both sides of the corrector lens to provide maximum light transmission.

Combined, this long list of features makes the NexStar® 11 GPS the ultimate portable, large aperture telescope. Ideal not only for lunar, planetary and deep sky observing, but also for astrophotography and CCD imaging.

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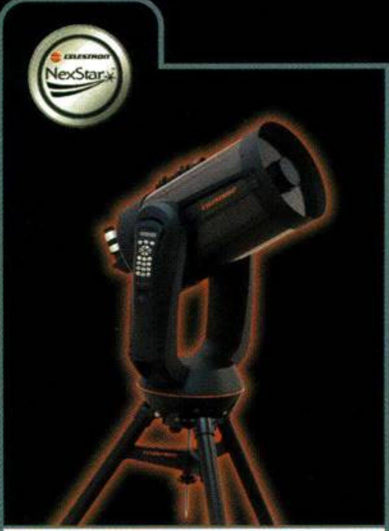

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Laser Use Rules

On page 96 of the December 2000 issue, a green laser pointer was featured as a useful tool for pointing out stars. I don't think it's a good idea to encourage more people to flash laser beams into the night sky. I understand that lasers can interfere with a pilot's ability to see. — *Scott Murphy, Danville, Virginia*

Mr. Murphy is right to warn about potential hazards. When using visible laser pointers of moderate power (around 5 milliwatts) for astronomical identification, please adhere to the following guidelines:

1) Never point a laser at or toward any moving light in the sky, even if the object is a "known" satellite.

2) Avoid laser use in urban areas, around airports, or near heavily traveled flight paths.

3) Aim the pointer above 20° elevation only. Aircraft operating at lower altitudes are at greater risk if they see a laser flash. Also, more aircraft fly in the volume of space intersected by a laser pointer aimed toward the horizon than in the same volume aimed straight up.

4) Restrict laser pointer use to only as long as necessary to identify an astronomical object.

5) Keep star-pointing sessions relatively short and infrequent. Coordinate any long-term or nightly use with your local FAA center.

6) Finally, never aim the laser at or near a person's eyes. A hand-held laser is a powerful source with light density greater than the surface of the sun. — Patrick Murphy, Pangolin Laser Systems, Orlando, Florida

Donna Colona

Patrick Murphy demonstrates how to point a hand-held laser at Alnilam in Orion's belt.

Christmas Light

Thank you for the wonderful articles on the Christmas eclipse in both the November 2000 and January 2001 issues. I teach fifth grade and your articles helped me prepare my class to view the eclipse safely. An entire lesson was based on what an eclipse is, why it happens, and how students could observe it. Your magazine was invaluable, as were the solar viewing glasses. Many students purchased the January 2001 issue and became amateur astronomers (at least for a day).

On a personal note, at midday December 25, eclipsed sunlight shone through my window and onto my Christmas tree. Reflected sunlight bounced off the ornaments, producing crescent suns all over my dining room as we enjoyed our holiday meal — a truly memorable and remarkable sight. — *John W. Flyte, Jr., East Stroudsburg, Pennsylvania*

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Bad Rap

Astronomy magazine often includes articles geared toward children. In the December 2000 issue, Bob Berman wrote about the things he is thankful for, including no music during star parties. He also mentioned that "listening to rap music should be a misdemeanor." I'm 16 and think that this comment reflects an intolerance that could keep teenagers away from astronomy. — *Mike Marshak, Baltimore, Maryland*

Actually, Mike, we listen to hip-hop quite a lot and sometimes even West Coast rap. We don't endorse every opinion of our writers, but let them express theirs. — Astronomy *editors*

Correction

Our apologies to astronomer Helen Hart, whose name was misspelled in a caption on page 49 of the February 2001 issue.

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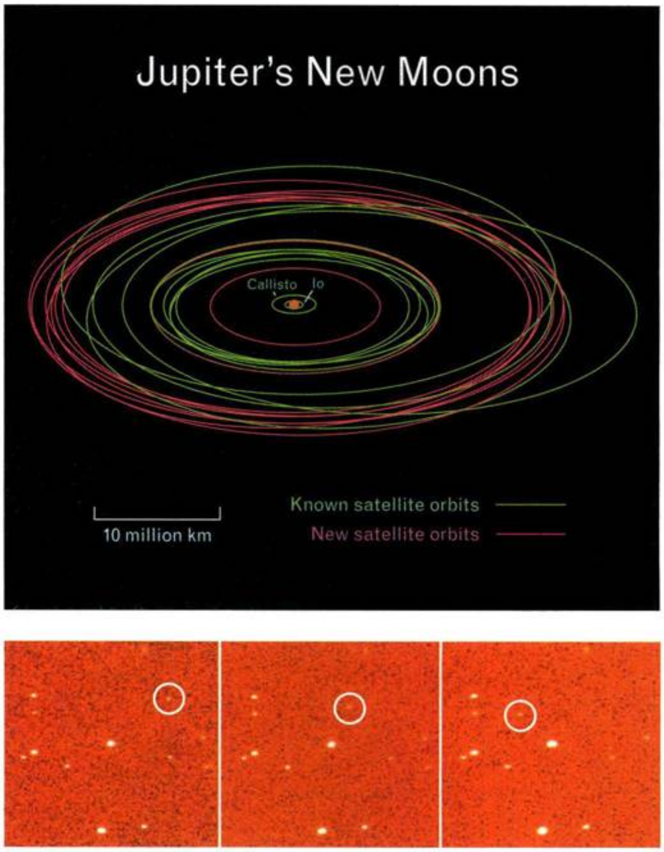
PLANETARY SCIENCE

Jupiter's Royal Court Grows by Eleven



University of Hawaii

The 11 new moons of Jupiter all orbit at distances well beyond the Galilean moons (top). The faint blip of S/2000 J8 (above, circles) moves noticeably relative to the stars in just 73 minutes.

▶ Although Jupiter has always been the king of the solar system, until last year Uranus was considered the most prolific of the noble gas giants, with a progeny of 21 moons. But now it seems that both Saturn and Jupiter have mounted a successful coup to topple Uranus from its perch. As we reported last month, Saturn currently holds the lead with a whopping 30 moons (see "Saturn's Moons Continue to Multiply," Event Horizon).

On January 5, 2001, a team of planetary scientists from the University of Hawaii's Institute for Astronomy shocked astronomers and relegated Uranus to the bronze-medal position when they reported the unprecedented discovery of 10 new jovian satellites. What's more, they found Jupiter's long-lost moon S/1975 J1, which disappeared shortly after its discovery in 1975. This easily ranks as the largest number of new moons reported at once and brings Jupiter's total now to 28 — enough for the giant planet to comfortably secure second place in the ongoing moon race.

Graduate student Scott Sheppard led the research team, which includes David Jewitt, Yan Fernandez, and Gene Magnier. Using a wide-field CCD detector attached to the University of Hawaii's 2.2-meter (88-inch) telescope atop Mauna Kea, the team searched the sky near Jupiter for objects moving against the background of stars. The astronomers then sent the imaging data for each suspected moon — officially dubbed S/2000 J1 through S/2000 J11 — to Brian Marsden at the Harvard-Smithsonian Center for Astrophysics, in Cambridge, Massachusetts, who computed and confirmed the orbital elements.

All of the new candidates belong to Jupiter's system of irregular satellites, meaning that they follow large, eccentric (elliptical) orbits that are highly inclined to the plane of Jupiter's equator. Astronomers believe that such irregular objects likely were captured by Jupiter when it was young.

Sheppard and his colleagues discovered nine of the candidates, designated S/2000 J2 – J10, between November 23, 2000, and November 26, 2000. Each of these objects orbits Jupiter at an average distance of 13 million miles (21 million km) and follows a retrograde orbit, meaning it revolves around Jupiter in the direction opposite to the planet's rotation. The team's discovery increases the number of Jupiter's known retrograde satellites from 5 to 14.

S/2000 J11 was discovered on December 5, 2000, and follows a prograde orbit at a distance of 7 million miles (11 million km) from the giant planet. Its discovery increases the number of known prograde irregular satellites to five.

S/2000 J1, detected on November 21, 2000, lies approximately 4 million miles (6 million km) from Jupiter. Marsden's analysis confirmed that it follows an orbit identical to that of S/1975 J1 — a satellite discovered and subsequently lost by Charles Kowal in 1975. Because the detection of S/2000 J1 verifies the existence of a moon that had been lost for 25 years, it doesn't exactly qualify as a new discovery. Nonetheless, it still raises Jupiter's total moon count by one.

Assuming each of the candidates reflects about 4 percent of the sunlight that reaches it (a value consistent with that of Jupiter's other irregular moons), the apparent brightnesses of the new objects suggest that they range from about 2 miles (3 km) to 5 miles (8 km) in diameter. The most distant moons should take a couple of years to complete an orbit of Jupiter.

Once observations confirm that these objects are actually new moons, the discoverers and the International Astronomical Union will take up the task of giving each a proper name.

— WILLIAM SCHOMAKER

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EXTRASOLAR PLANETS

Odd New Planets Discovered

Until the end of 2000, the zoo of known extrasolar planets was populated with wild beasts. One species was known as hot Jupiters — planets that orbit their host stars in tight circular orbits. The other was known as eccentric planets — planets that orbit a little farther out in highly elliptical orbits. But the new millennium has added two strange denizens to the menagerie: resonance planets and a whopper.

A team led by University of California at Berkeley astronomer Geoff Marcy announced the discoveries at the January meeting of the American Astronomical Society in San Diego, California. The new planets orbit the stars Gliese 876, a red dwarf just 15 light-years from Earth in Aquarius, and HD 168443, a solar-type star 123 light-years away in Serpens. In 1998, Marcy's team found a single planet orbiting each of these stars. By finding companions, the team has raised the number of known planetary systems around normal stars to five.

The two resonance planets orbit Gliese 876 with periods in a nearly 2:1 ratio. The new planet revolves every 30.1 days while the previously known one goes around in 60.9 days. The near 2:1 ratio is reminiscent of the 4:2:1 resonance of Jupiter's moons Io, Europa, and Ganymede.

"These planets gravitationally shepherd each other to maintain this 2:1 synchrony, their elliptical orbits nested and aligned like Russian Matrioshka dolls," says team member Debra Fischer of UC-Berkeley.

The inner planet contains about half Jupiter's mass and orbits Gliese 876 at 0.13 astronomical unit (1 AU is the average Earth-sun distance). The outer planet has at least twice Jupiter's mass and orbits at 0.21 AU.

Although no one knows for sure how the planets ended up in this resonance, calculations by Jack Lissauer of NASA's Ames Research Center suggest one possibility. He thinks gravitational interactions with the star's protoplanetary disk caused both planets to migrate inward. The inner planet eventually cleared out its region of the disk and stopped migrating. "The outer planet continued to migrate inward until the resonance coupled the two planets," says Lissauer.

Like most of the 55 or so known extrasolar planets, Gliese 876's are not small. But the HD 168443 planetary system consists of two bona fide heavyweights. The planet found in 1998 contains between 7.7 and 15 Jupiter masses while the new planet, which orbits farther from the star, weighs in at 17 to 40 Jupiter masses.

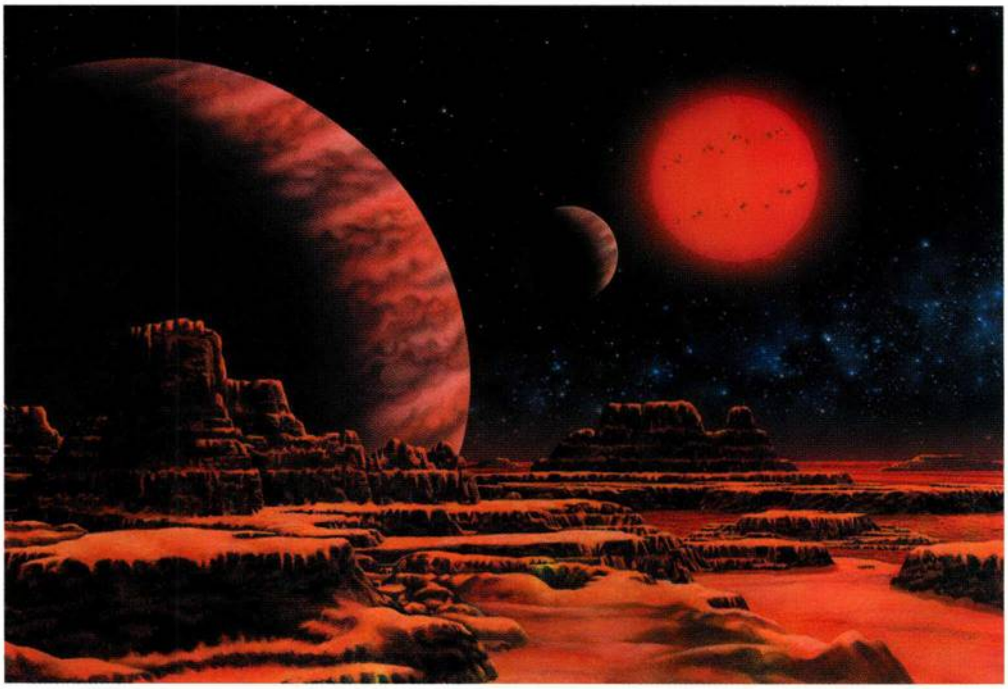
"The outer planet is the whopper. It's off our scale. It's twice as massive as any planet we've seen," says Marcy's colleague Paul Butler of the Carnegie Institution of Washington. "The outer companion is the puzzler," adds Marcy. "We don't know if it's a planet, a brown dwarf, or some sort of hybrid."

Under normal circumstances, most astronomers would consider the outer planet to be a brown dwarf rather than a planet. Brown dwarfs are usually defined as objects between 13 and 80 Jupiter masses — the mass range in which a substellar object briefly can fuse deuterium in its core.

But the problem is that the HD 168443 system looks like a planetary system. Computer simulations by Greg Laughlin of NASA/Ames show that the highly elliptical orbits of the two companions, at average distances of 0.3 and 2.8 AU, are extremely stable if they lie in nearly the same plane. This configuration implies that the objects formed together inside a disk, the way planets are believed to form. But until now, astronomers didn't think disks could spawn planets with masses much greater than 10 Jupiters.

Unlike the giant planets in our solar system, which probably formed as gas accreted onto cores of ice and rock, Laughlin thinks HD 168443's planets formed when the protoplanetary disk fragmented into two or more clumps of gas that collapsed rapidly to form the massive planets. "It's hard to imagine these planets forming from accretion of gas onto solid cores," he says. "That would require a very massive disk at a late stage in the game."

— ROBERT NAEYE, ASTRONOMICAL SOCIETY OF THE PACIFIC



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PULSARS

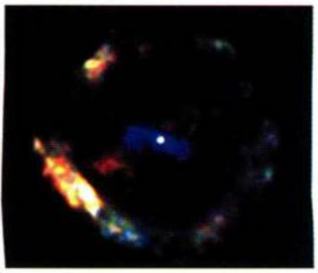
Ages of Pulsars May Be Wrong

▶ A thousand years ago, most astronomers thought Earth lay at the center of the universe. One hundred years ago, most thought the cosmos consisted of one galaxy. And just last year, most would have said they understood how neutron stars and pulsars evolve. Conventional wisdom, it seems, has taken another beating.

Neutron stars — objects having the mass of a couple suns crushed into a sphere the size of a city — form when a massive star dies. After a few million years of a profligate life, the star exhausts the nuclear fuel in its core. With no energy source to counteract the crushing force of the star's overlying layers, the core collapses and the star explodes. The resulting supernova can outshine all the stars in a galaxy. The collapsed core remains, either as a neutron star or, more rarely, a black hole.

These neutron stars spin at extraordinary speeds, up to a few dozen times a second. They also emit radiation from their magnetic poles and, if Earth happens to be positioned just right, we see the star flash on and off like a lighthouse beacon: a pulsar. Astronomers can measure the timing of these pulses with incredible precision and, in every case, the pulsars are seen to be slowing down. Measure the rate of slowdown and the actual period of the pulsar and, voilà, you know how old the pulsar must be.

The pulsar at the center of this supernova remnant appears to have been born spinning much slower than thought possible.



NASA/McGill University/V. Kaspi, et al.

The only problem is that scientists had only one concrete example that supported this scenario. Despite knowing thousands of pulsars and thousands of supernova remnants, only the pulsar at the center of the Crab Nebula in Taurus could be tied unequivocally to a supernova seen in historic times. And that pulsar's slowdown rate showed it formed about 1,000 years ago — a good match considering the nebula was born in a supernova witnessed on Earth in the year 1054.

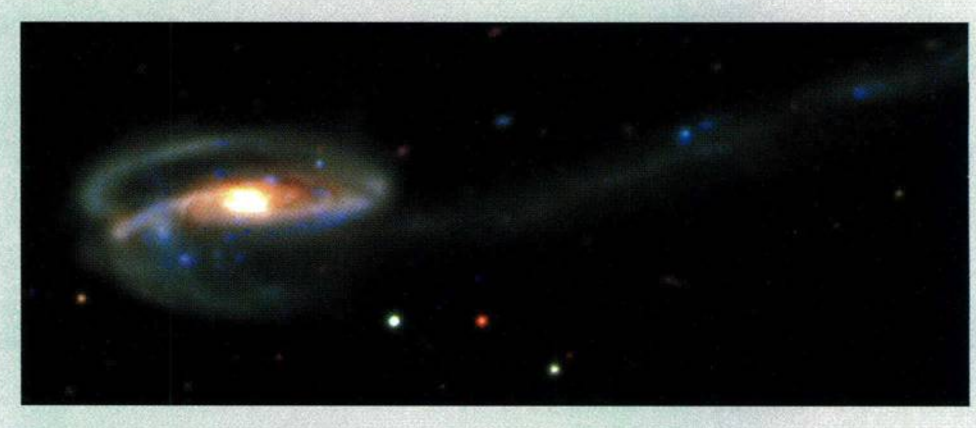
Now Victoria Kaspi of McGill University in Montreal and her colleagues have used the Chandra X-ray Observatory to make a definitive link between a pulsar and a supernova remnant in Sagittarius cataloged as G11.2–0.3. The supernova was recorded by Chinese astronomers in the year 386 — 1,615 years ago. But the slowdown rate of the pulsar indicates that it formed 24,000 years ago.

"We believe that the pulsar and the supernova remnant are both left over from the explosion seen by Chinese astronomers more than 1,600 years ago," says team member Mallory Roberts of McGill University. "While this is exciting by itself, it raises new questions about what we know about pulsars, especially during their infancies."

The researchers think the discrepancy arises because pulsars are not all born with the same spin. They think the pulsar in G11.2–0.3 formed with a spin near its current value of 14 times per second — a far cry from the Crab pulsar, which astronomers believe had an initial spin of roughly 60 times a second. If true, it means that the ages derived for the thousands of other known pulsars may have little relationship to reality. And it means the world of pulsars and neutron stars just got more complicated, and interesting.

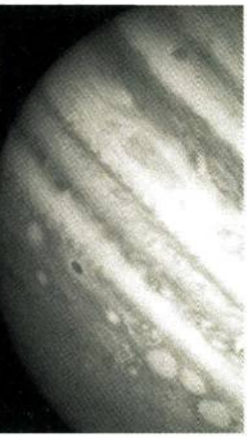
— Richard Talcott

Dark Galaxies?



Neil Trentham (University of Cambridge), et al.

SOMETIMES, BELIEVING COMES EVEN without seeing. Astronomers have long suspected that much of the universe is composed of a ubiquitous yet unseen form of dark matter. Many galaxies seem to possess 10 times the collective mass of the stars they contain. Others seem so devoid of stars that it's a mystery why they haven't flung themselves apart. And now some scientists believe that completely dark galaxies — galaxies with no stars at all, only dark matter — may outnumber normal galaxies 100 to 1. University of Cambridge astronomers Neil Trentham, Ole Moller, and Enrico Ramirez-Ruiz think they may have spotted one of these mysterious darkling bodies. This image, taken with the 2.5-meter Isaac Newton Telescope in the Canary Islands, shows a stream of material leaving the galaxy UGC 10214, presumably stripped by a neighboring galaxy. But UGC 10214's neighbor is nowhere to be found.



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MARS GLOBAL SURVEYOR

The Red Planet Turns Green

The moon may not be made of green cheese, but if two U.S. scientists are right, Mars might at least have some green craters. According to Roger Clark and Todd Hoefen of the U.S. Geological Survey (USGS) in Denver, new data from the Mars Global Surveyor spacecraft indicate a green volcanic mineral called olivine covers vast areas of the martian surface. The presence of this mineral on crater rims and plateaus may help planetary scientists better understand the history of Mars.

The researchers found an abundance of olivine in the Nili Fossae region of Mars, a plateau located in the planet's northern hemisphere. Yet olivine breaks down quickly in the presence of water. "We'd expect the olivine to migrate to the surrounding lowlands of Elysium and Isidis if there had been heavy erosion," says Hoefen. Instead, they found high levels of the mineral on the plateau and no evidence of it in the lower regions. In addition, minerals that should have been left behind by weathering are not present. "We believe the data indicate that Mars has been dry and cold for much longer than most people thought," explains Hoefen.

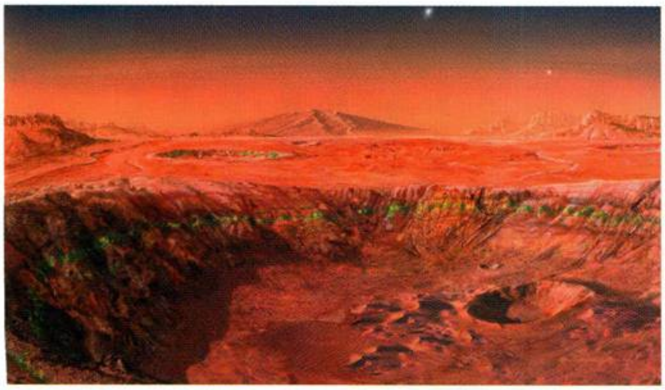
USGS planetary scientist Jeff Kargel agrees with this conclusion. He points out that the new results are supported by studies of martian meteorites. "There are signs of chemical alteration in Allan Hills and other meteorites, but it's not extreme. This implies that they've experienced little weathering," offers Kargel.

Hoefen and Clark base their findings on information returned by Mars Global Surveyor's Thermal Emission Spectrometer (TES). The TES spectrum of the Nili Fossae region closely resembles the laboratory spectrum of olivine.

Planetary scientists have yet to grasp the full implications of the olivine's presence on Mars. But with possibly one million square miles of the planet covered by the verdant substance, future explorers may be treated to spectacular vistas of red soil encrusted by glistening green crystals. "That," says Hoefen, "would be worth the trip."

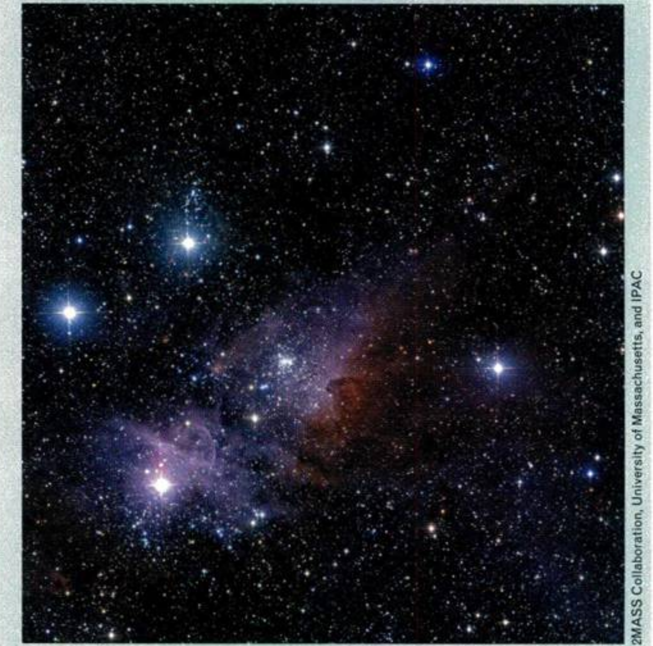
— Michael Carroll

New data suggest that the green, volcanic mineral olivine covers much of Mars's surface.



Michael Carroll

2MASS PROJECT



2MASS Collaboration, University of Massachusetts, and IPAC

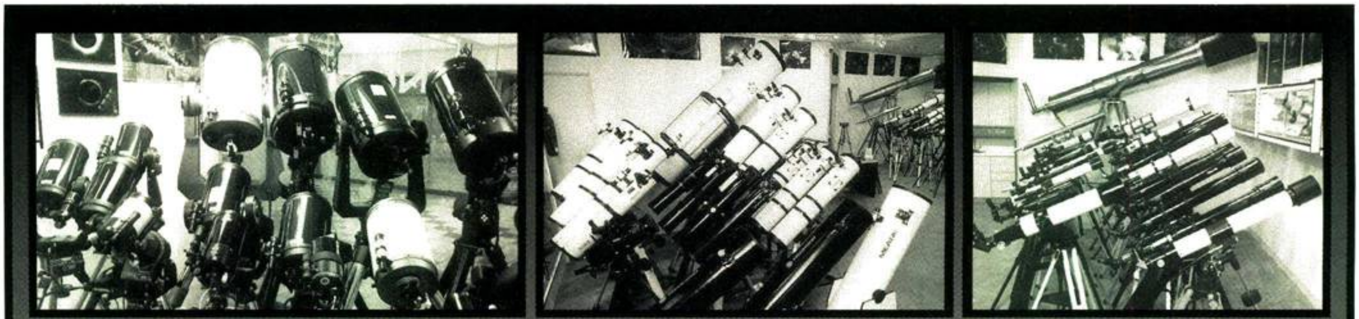
A MASSIVE BURST OF STAR FORMATION about 3 million years ago set the Eta Carinae Nebula (NGC 3372) ablaze with light. Today, the gas- and dust-filled nebula, located 7,500 light-years from Earth in Carina, harbors many bright stars and star clusters. It's also home to the famous luminous blue variable star Eta Carinae, seen toward the nebula's southeastern (lower left) edge. Tipping the scales with a mass of 100 suns, this star ranks as one of the most massive in the Milky Way Galaxy and has also undergone several outbursts during the past two centuries. This image was taken as part of the Two-Micron All Sky Survey (2MASS), an effort to map the entire sky in infrared light.

BLACK HOLE FORMATION

Bucking Black-Hole Rules

According to the latest study, astronomers may have to rethink the relationship between supermassive black holes and their host galaxies. Last December at the 20th Texas Symposium on Relativistic Astrophysics in Austin, Texas, a team of researchers led by Amy Barger of the University of Hawaii's Institute for Astronomy and the University of Wisconsin laid out convincing x-ray, optical, submillimeter, and radio evidence that challenges the conventional understanding of supermassive black holes.

Barger and her colleagues conclude that many of these giant black holes, each *possessing* the mass of millions or even billions of suns squeezed into a region



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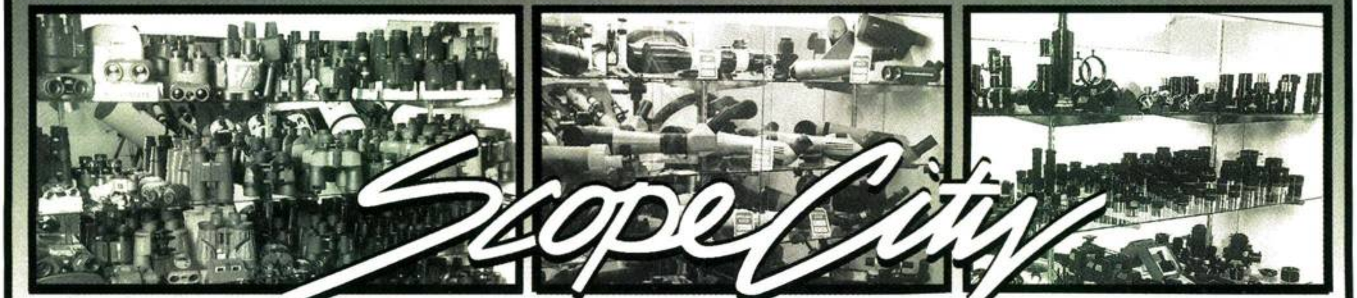

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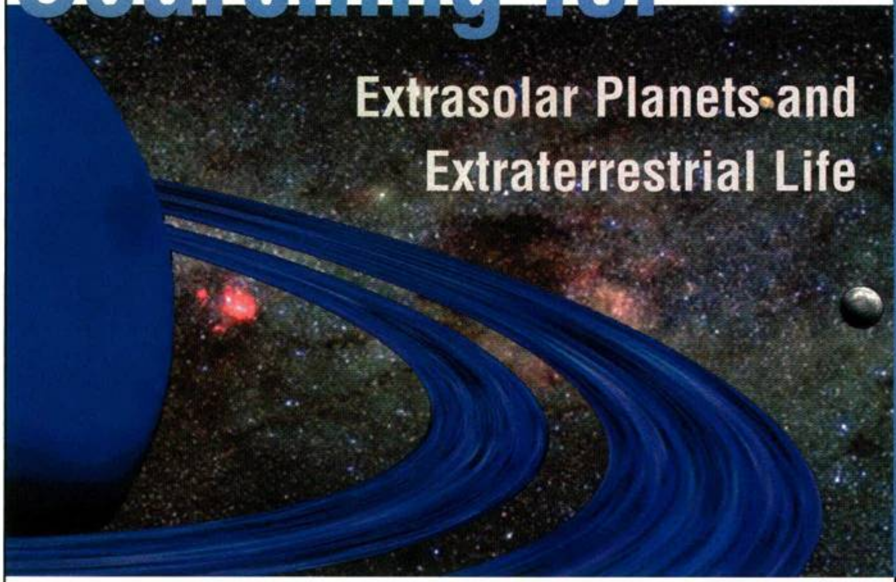

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no larger than the solar system, formed relatively recently. And they believe that some may still be forming today. At the root of the controversy lies new information that about 10 percent of all supermassive black holes in the universe are actively accreting huge quantities of gas, dust, and even entire stars at any given time — sometimes with enough ferocity to outshine all the stars in the host galaxy combined.

"At least 15 percent of supermassive black holes have formed since the universe was half its present age," says Barger. "This challenges the widely held view — based on the relationship between the sizes of black holes and their host galaxies — that the black holes formed when the galaxies formed. Instead, it seems that some black holes are still growing."

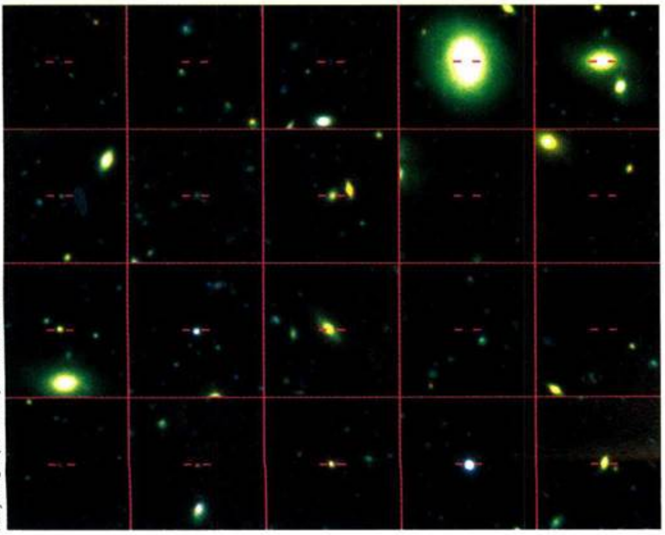
Until recently, astronomers have been hesitant to fully accept that every large galaxy in the universe might harbor a supermassive black hole at its core (see "Here, There, and Everywhere?" February 2001). Although this idea is steadily gaining favor, the standard belief has been that such supermassive black holes likely formed first while galaxies grew up around them — the so called "inside-out" theory of galaxy formation.

According to Barger's team, the answer might not be so clear-cut. Their research actually favors the competing "outside-in" theory — where the galaxy forms first and stars, gas, and dust later trickle to the core to create the supermassive black hole engine.

Barger, along with Lennox Cowie of the Institute for Astronomy, Richard Mushotzky of NASA's Goddard Space Flight Center, and Eric Richards of NASA's Marshall Space Flight Center, used the 10-meter (33-foot) Keck Telescope, the James Clerk Maxwell Telescope (both atop Mauna Kea in Hawaii), and the Very Large Array in New Mexico to obtain optical, submillimeter, and radio observations of distant galaxies with actively accreting black holes. The galaxies belong to the ubiquitous x-ray background, resolved earlier in the year by NASA's Chandra X-ray Observatory.

Such a multi-wavelength assault on these previously unresolved x-ray sources allowed Barger and her team to trace the accretion energy produced by supermassive black holes throughout the history of the visible universe. Optical data offered them a window to the time when the black holes were most active, while the submillimeter and radio data allowed them to estimate the amount of energy produced as the black holes formed.

Based on the evidence that 10 percent of supermassive black holes actively accrete matter at any time in the history of the universe, Barger's team concludes that the process responsible for creating these black holes is actually quite slow: It appears that some galaxies *might spend billions* of years molding supermassive black holes at their cores. — W. S.



Amy Barger (University of Hawaii), et al.

The optical counterparts to 20 x-ray sources range from bright galaxies to barely visible objects. A new study shows that some of the *giant black* holes that power these x-ray sources formed fairly recently in the universe's history.

VIRGO CLUSTER

George Jaboby (Kitt Peak National Observatory)

LIKE A FLOCK OF FIREFLIES, the central region of the Virgo Cluster of galaxies glimmers in the springtime sky. Home to roughly 2,500 galaxies, including favorites such as the giant ellipticals M86 (center) and M84 (right), this irregular cluster lies approximately 50 million light-years from Earth. That makes it the nearest large galaxy cluster and the center of the entire Local Supercluster — a giant celestial conglomeration measuring some 100 million light-years across. The Local Group, home of the Milky Way and Andromeda galaxies as well as the Magellanic Clouds, lies near the outer boundary of the Local Supercluster. This image, which spans about 0.8° by 1°, was taken with the Mosaic camera mounted on the National Optical Astronomy Observatory's 0.9-meter (36-inch) telescope, located atop Kitt Peak in Arizona.

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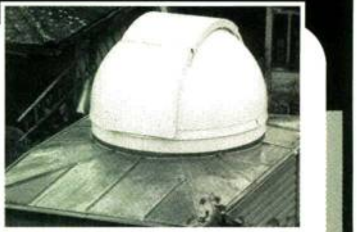

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SUPERNOVA 1987A

Jets May Trigger Supernovae

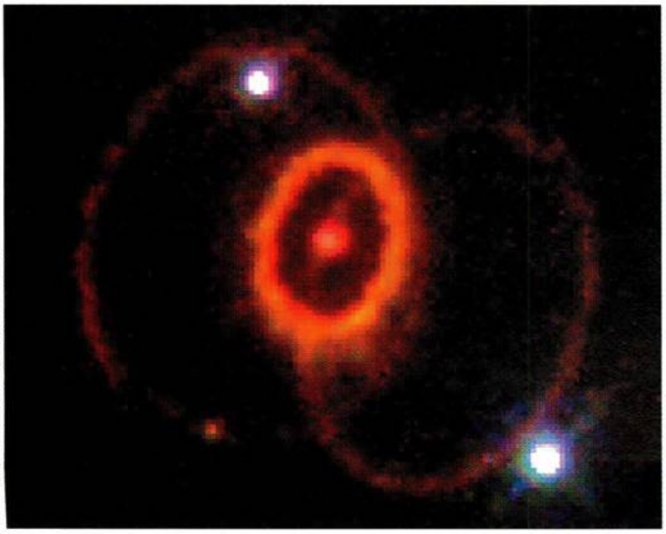
An international group of astronomers recently placed a new spin on an old favorite. In February 1987, Supernova 1987A delighted scientists as well as the public when it exploded in the nearby Large Magellanic Cloud. A team led by University of Texas astronomers Lifan Wang, Peter Höflich, and J. Craig Wheeler announced in December the results of more than 10 years' worth of research on the rapidly expanding supernova remnant. The work stands to question and ultimately revolutionize our understanding of the events that precede one of the most violent events in the universe: the detonation of a supernova.

Conventional wisdom dictates that a detonation driven by neutrinos created when a dying star's iron core collapses should be spherically symmetric. Moreover, the ejecta should be symmetric and chemically homogeneous. Yet 1987A has consistently contradicted this wisdom.

The latest Hubble observations of 1987A indicate that a bipolar, jetlike explosion — oriented perpendicular to the easily seen rings —likely produced the unusual geometry of the famous remnant.

New models suggest that jets of radioactive nickel can become focused along bipolar axes, which may align with the spin or magnetic axis of a newly formed neutron star. As these jets plow through the nearby interstellar medium, shock waves propagate along the surface of the core and focus at the equator, blowing off heavy elements.

Theorists believe that if the jets are able to funnel vast quantities of energy from the collapsed core's rotation, they may provide enough energy to trigger the supernova explosion. The researchers add that the observations of 1987A consistently support the new jet-induced explosion models. — W. S. A



New observations suggest that Supernova 1987A's unusual geometry may have resulted from a bipolar, jetlike explosion.

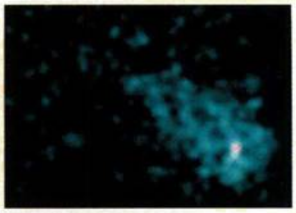
Christopher Burrows, ESA/STScI, and NASA

Calling All Space Artists

In conjunction with their *Red Rover Goes to Mars* project, the Planetary Society is sponsoring an all-ages art contest. Lend them your artistic hand by sending two illustrations, depicting a ground-level view of a martian landing site as it is today and how it will look 100 years later. Contest rules stipulate that entries must be done entirely by hand — drawn, painted, or by an alternative two-dimensional method (no computers allowed). A brief description of the artwork must accompany the drawings. But don't delay, the deadline for submissions is April 2, 2001. Complete details can be found on the Society's homepage at http://www.planetary.org, or by writing to International Space Art Contest, c/o The Planetary Society, 65 North Catalina Avenue, Pasadena, California, 91106. Artwork will be judged on creativity, knowledge of Mars, and artistic merit in three age categories: 10 and under, 11 to 18, and 18 and over.

Rising Stars Discover Pulsar

On December 11, 2000, three high school students took first place in the Siemens–Westinghouse Science and Technology Competition. On top of that, they made one of the year's more significant contributions to astronomy. Using data from NASA's Chandra X-ray Observatory and the Very Large Array, Charles Olbert, Christopher Clearfield, and Nikolas Williams of the North Carolina School for Science and Mathematics in Durham pinpointed the compact stellar remnant of an ancient explosion. A unique combination of x-ray and radio data allowed the budding scientists to conclude that this newly discovered pulsar is plowing through the supernova remnant IC 443, located some 5,000 light-years from Earth, and that the supernova explosion occurred about 30,000 years ago.



The neutron star in IC 443 shows pink in this x-ray image.

NASA/NCSSM/C. Olbert, et al.

Tip of the Star-Forming Iceberg

Astronomers have long suspected that the Orion star-forming region is teeming with young stars that may be forming planets. Nonetheless, an international team of scientists led by Cesar Briceno of the Center for Research in Astronomy in Venezuela was surprised to find 168 low-mass, infant stars, each between 1 million and 10 million years old. And they've examined only ⅙ the area they expect to cover. Their analysis indicates that these stars lack dusty disks, which are common in stars less than 10 million years old. The researchers contend that the dust is missing because it has coalesced to form large bodies such as planets. If correct, it suggests that planets can form in as little as 10 million years — 100 times quicker than previously thought possible.

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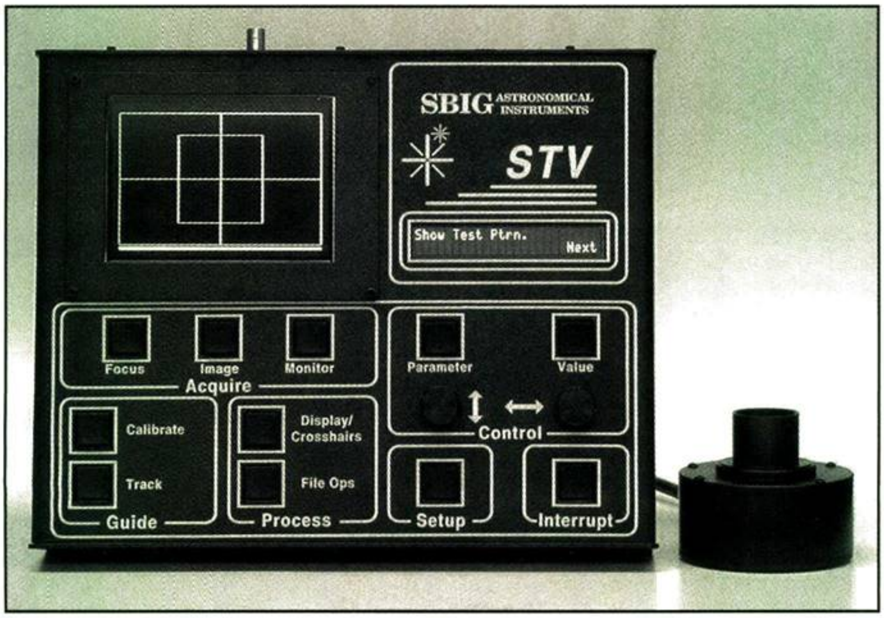
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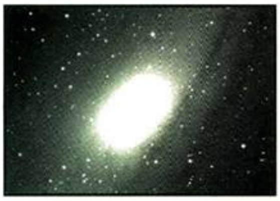
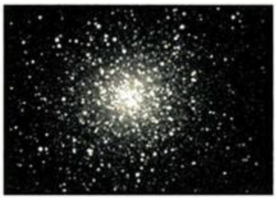
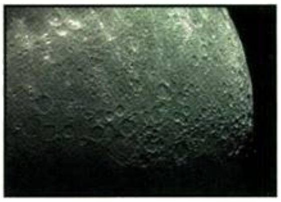

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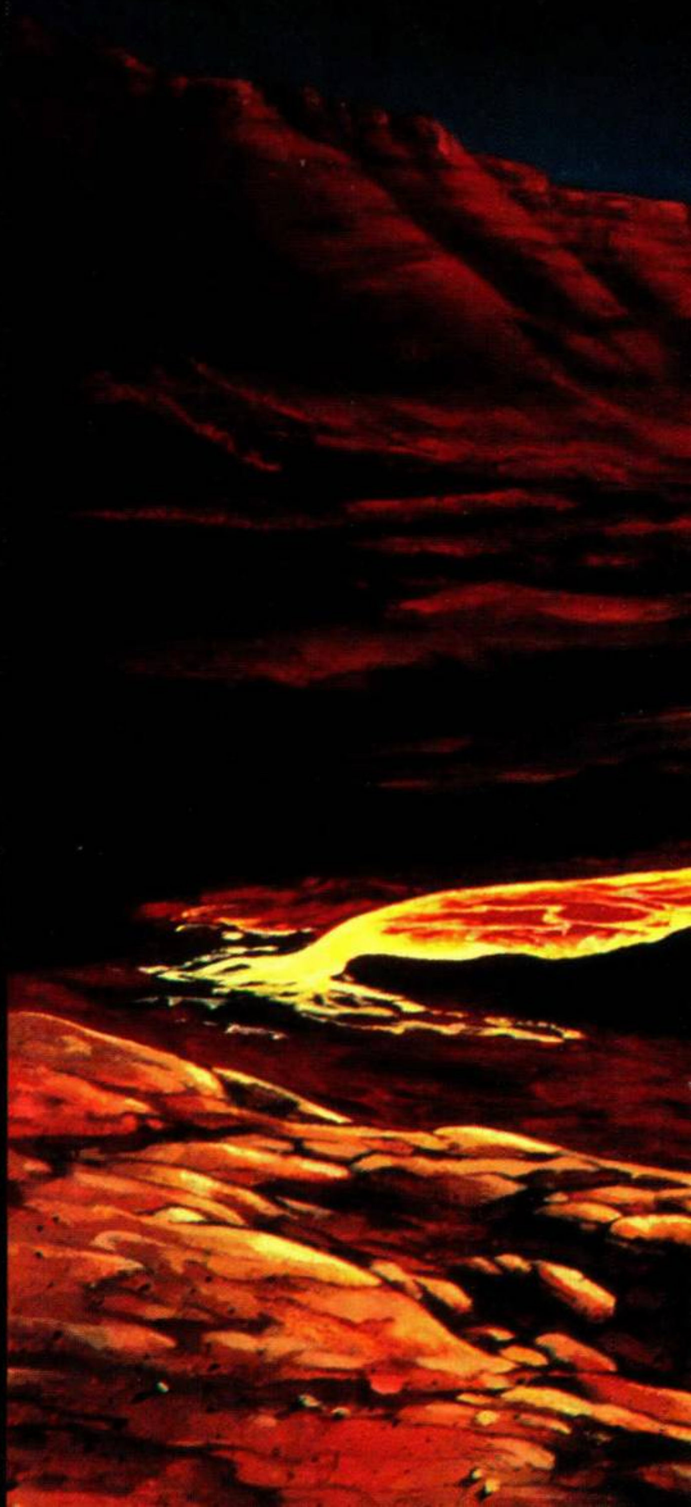
A GIANT AWAKE

NASA's latest spacecraft sped by the giant planet in December, returning thousands of new images to Earth.

by Richard Talcott



Painting by Pamela Lee; all images: NASA/JPL/University of Arizona

Halfway to its ultimate destination, the weary traveler needed a boost. Slowly opening its electronic eye, the robot explorer awakened to a landscape of erupting volcanoes, frozen oceans, and hurricane-force winds. After taking some snapshots, sampling the rarefied air, and getting a needed jolt of energy, the robot went back to sleep, not to be roused for another three years.

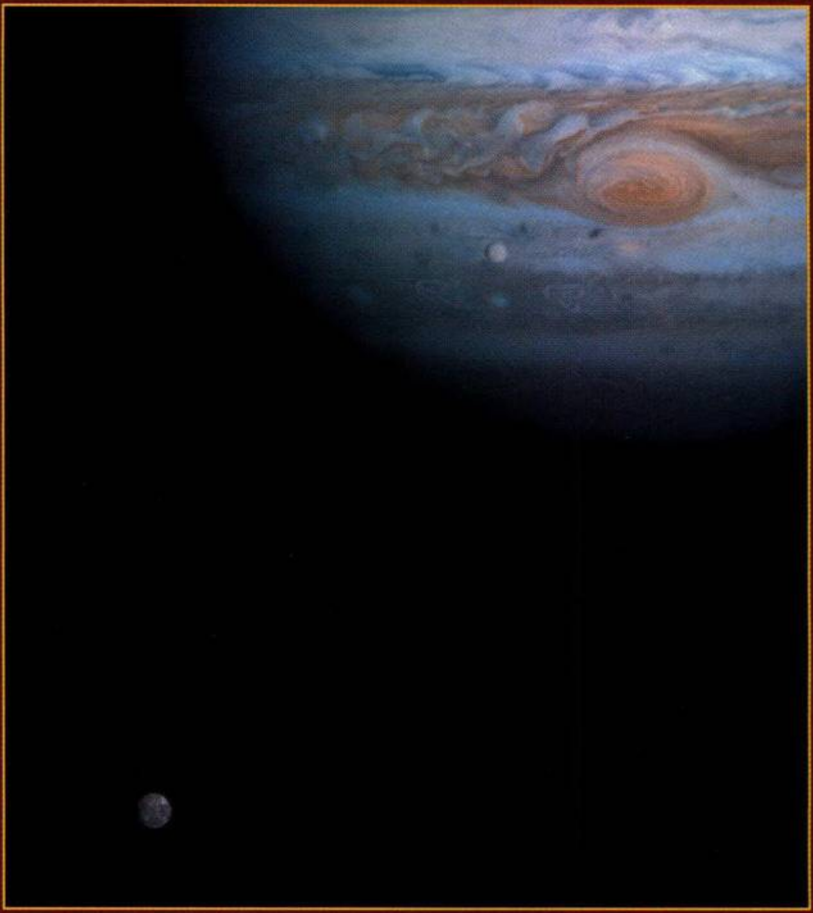
The intrepid explorer — named Cassini after the 17th-century observer who changed our view of the gas-giant planets — was paying a visit to Jupiter. The largest planet in the solar system, Jupiter provided Cassini just what it needed: a gravity assist to propel it on to a rendezvous with Saturn in 2004.

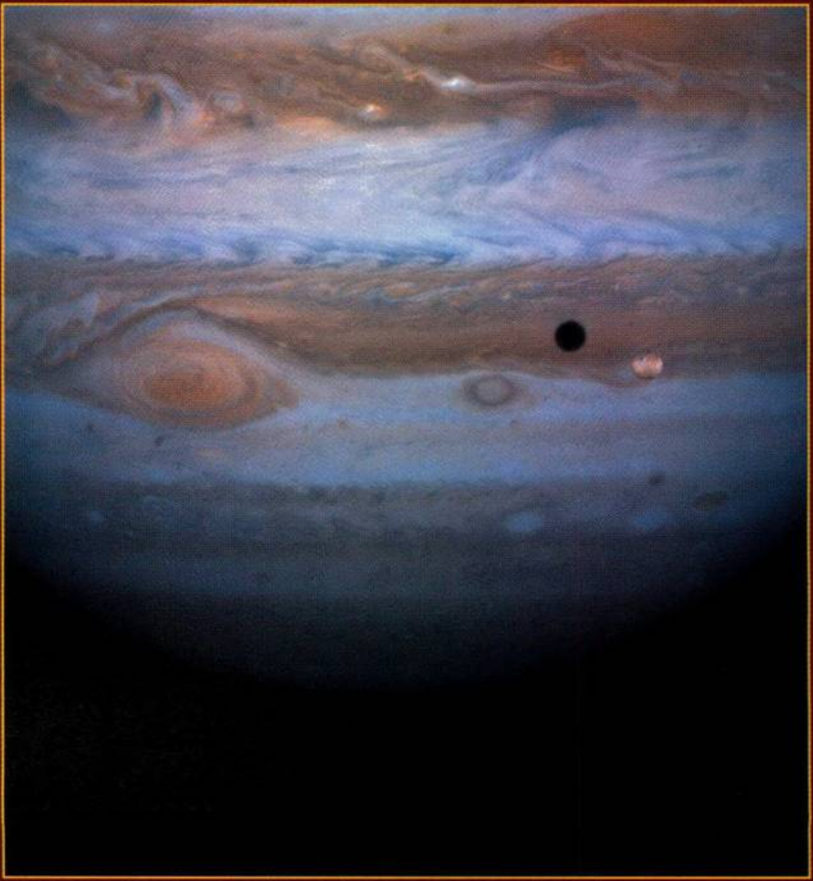
NS CASSINI

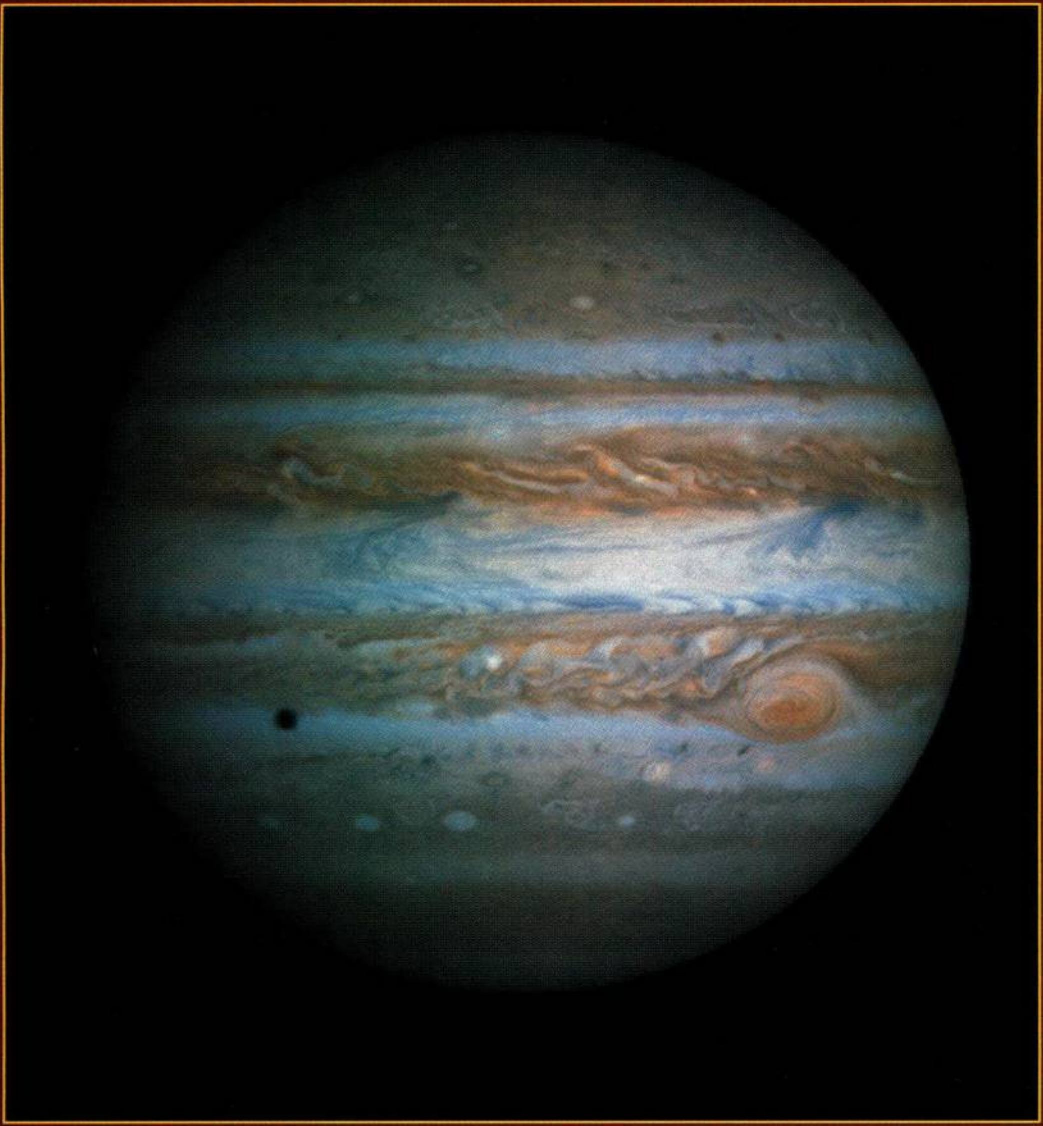
Despite being a long way from home, Cassini wasn't alone at Jupiter. The Galileo spacecraft has been patiently orbiting the giant planet for the past five years. That battered but durable veteran has already survived twice as long in orbit and absorbed three times as much radiation as it was designed to. Compared with Galileo, Cassini seems like a promising rookie. And what promise it has: Launched eight years after Galileo, Cassini comes armed with an array of instruments considerably more advanced than those on its older cousin.

NASA simply couldn't pass up the opportunity to have two spacecraft simultaneously focusing all their attention on the jovian system. Dubbing this two-pronged attack the Jupiter Millennium Mission, NASA hoped the joint observations would help clarify how the electrically charged particles of the solar wind interact with Jupiter's magnetosphere. This mammoth bubble contains charged particles trapped by the planet's immense magnetic field.

Planetary scientists also planned to study the thin atmospheres of Io and Ganymede by observing them as they passed into Jupiter's shadow, examine the three-dimensional structure of the planet's dark rings, probe the charged particles and dust ejected from Io, and observe the changing weather patterns in the planet's atmosphere. Just as important, the Cassini flyby would serve as a vital dress rehearsal for the future Saturn encounter.





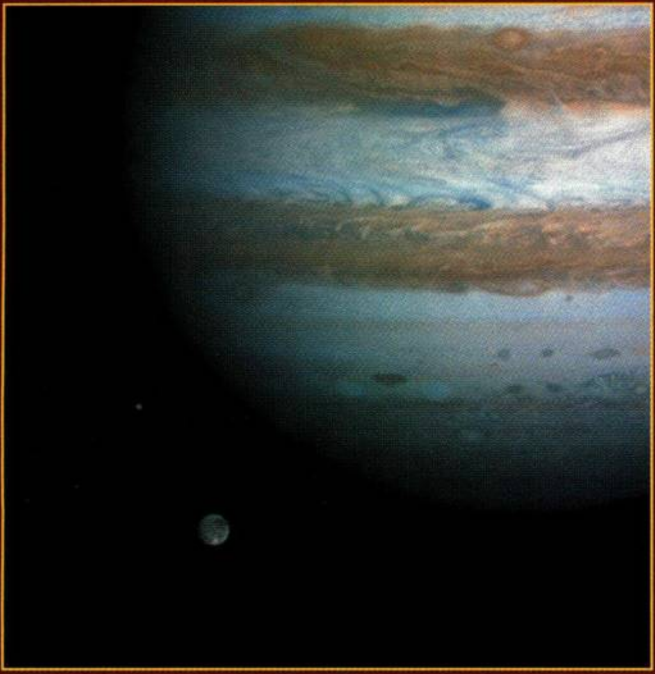


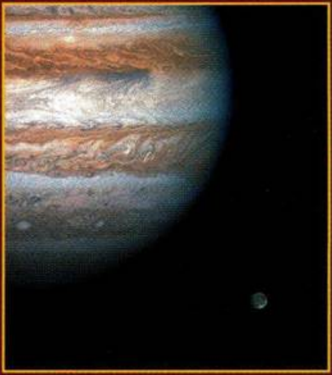
As Cassini approached Jupiter, it watched the moons play tag. Both Europa, seen against the planet, and Callisto were caught in one image (opposite, top). Although Callisto is 50 percent bigger than Europa, it's three times darker; it had to be brightened here.

Io and its shadow posed on December 12 (opposite, bottom). The white and red areas on volcanic Io come from sulfur compounds while black signifies silicate rocks.

A high-resolution, true-color mosaic of Jupiter (left) consists of four images taken on December 7. It reveals details as small as 90 miles across in the planet's atmosphere.

Ganymede — the largest moon in the solar system — took the spotlight in the images below. Darker regions on this moon represent older and more heavily cratered terrain.

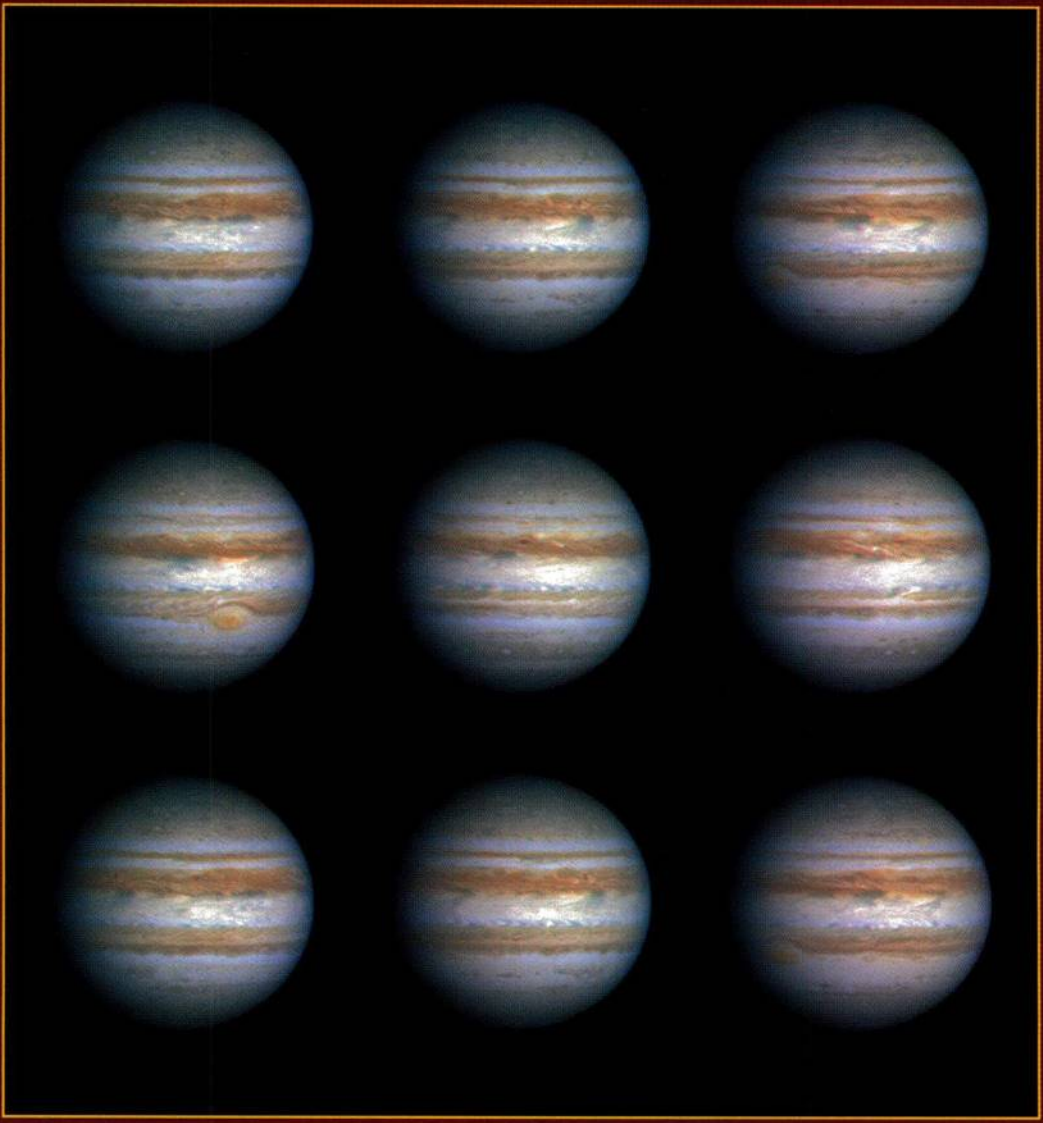


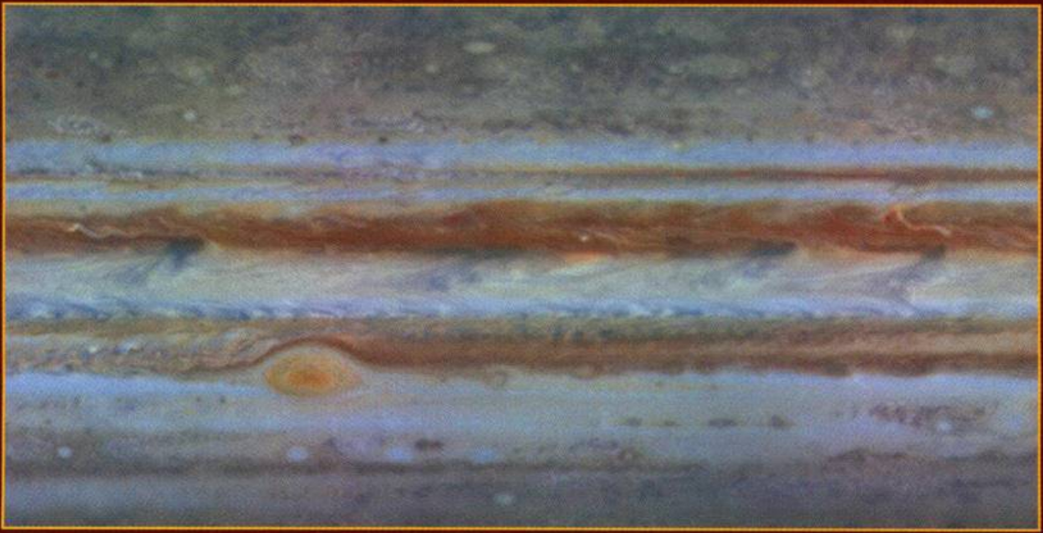


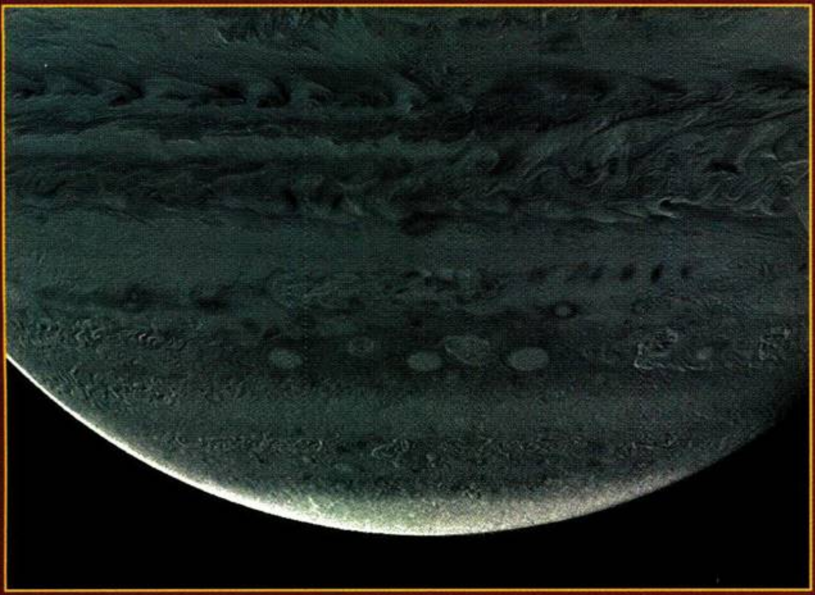
Despite its size, Jupiter rotates in less than 10 hours. A sequence of images (right; move left to right across each row and then down) shows a little more than one rotation. Cloud features, including the Great Red Spot on frames three and four, move from left to right and then disappear over the limb.

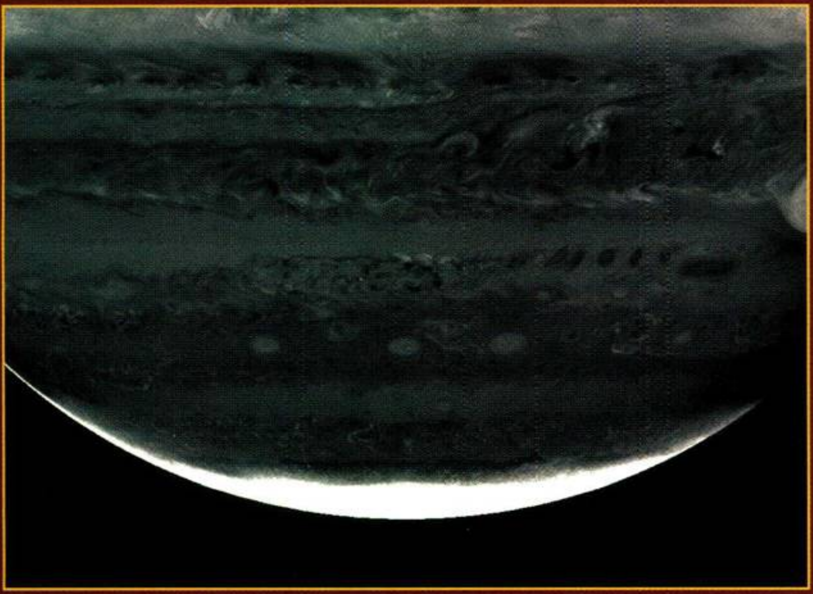
A strip taken from a time-lapse movie (below) shows Jupiter from 60° north to 60° south latitude centered near the Red Spot. Such movies show the Spot's rotation and white ovals rolling over and past each other.

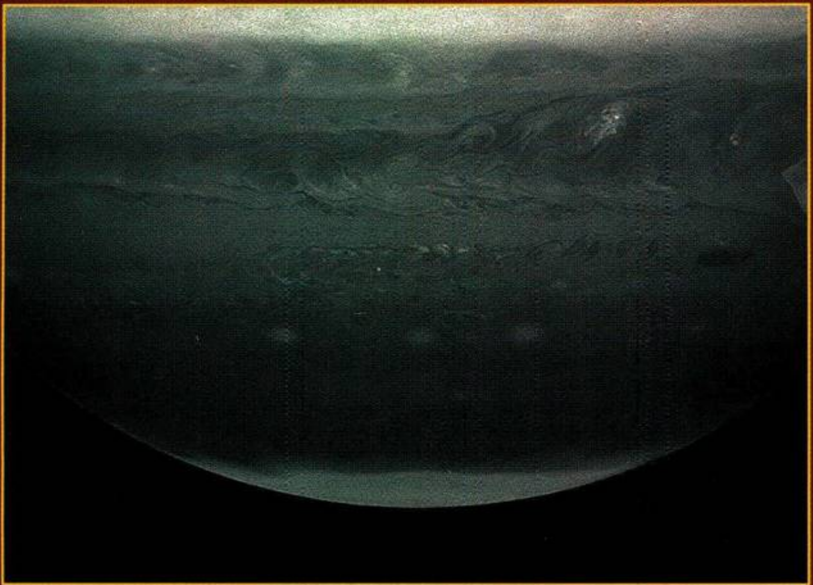
Three of the filters on Cassini's camera sample where methane absorbs light, at 619 nanometers, 727 nm, and 890 nm (opposite page, top to bottom). The top view penetrates deep into the atmosphere while the bottom one shows only very high clouds. The most prominent feature is stratospheric haze above the south pole.











The mutual observations got underway in early October when Cassini transmitted its first images and data to Earth. At the time, the spacecraft was 52.6 million miles (84.7 million km) from Jupiter.

Over the course of the next couple of months, Cassini pulled slowly closer. By the time of closest approach on December 30, it was still a healthy 6.04 million miles (9.72 million km) away. That's much farther than the Galileo and Voyager spacecraft achieved, so the resolution of the Cassini images doesn't match that of the earlier missions. Yet the leisurely pace of the Cassini flyby combined with the ability to record and transmit large amounts of data made it possible to record changes in Jupiter's dynamic atmosphere with exquisite precision.

The spacecraft's approach was not without incident, however. One of Cassini's electric reaction wheels — used to rotate the spacecraft — built up too much friction. When the craft automatically switched to a system that uses hydrazine-fueled thrusters, mission managers quickly shut it down because they needed to conserve the precious fuel for Saturn. So from December 19 to 28, all observations that required pointing the spacecraft, including imaging, were suspended.

Bob Mitchell, Cassini program manager at the Jet Propulsion Laboratory, thinks the problem arose from operating the reaction wheel at low speeds for too long, reducing the lubrication.

"That's our leading theory," he says, "but we may never know for sure." The problem has now passed and engineers think they can prevent any recurrence.

Early results from the flyby show that Cassini passed inside Jupiter's magnetosphere at a distance of 8.7 million miles (14 million km) from the planet. Galileo, just half as far away at that time, was also inside. Yet within a few hours both spacecraft lay outside. Apparently a strong gust of solar wind quickly and severely shrunk the size of the magnetosphere.

Images of the planet and moons, even from far away, show plenty of detail. Photos of the jovian atmosphere reveal that small thunderstorms can apparently harvest energy from below the cloud layer and larger storms then feed off the smaller ones. Imaging team leader Carolyn Porco of the University of Arizona exults, "The camera has performed beyond our wildest imaginings — and that's saying something, because we've been imagining this for a decade."

As Cassini pulls away from Jupiter, it will continue observing the planet until March 22. So you can expect to see many more images and results during the coming months. But for those of us waiting breathlessly for 2004, rest assured that Jupiter gave Cassini what it needed — a 4,500 mile-per-hour boost that has it heading right for Saturn. ■

Richard Talcott is a senior editor at Astronomy *who has been closely following Cassini.*

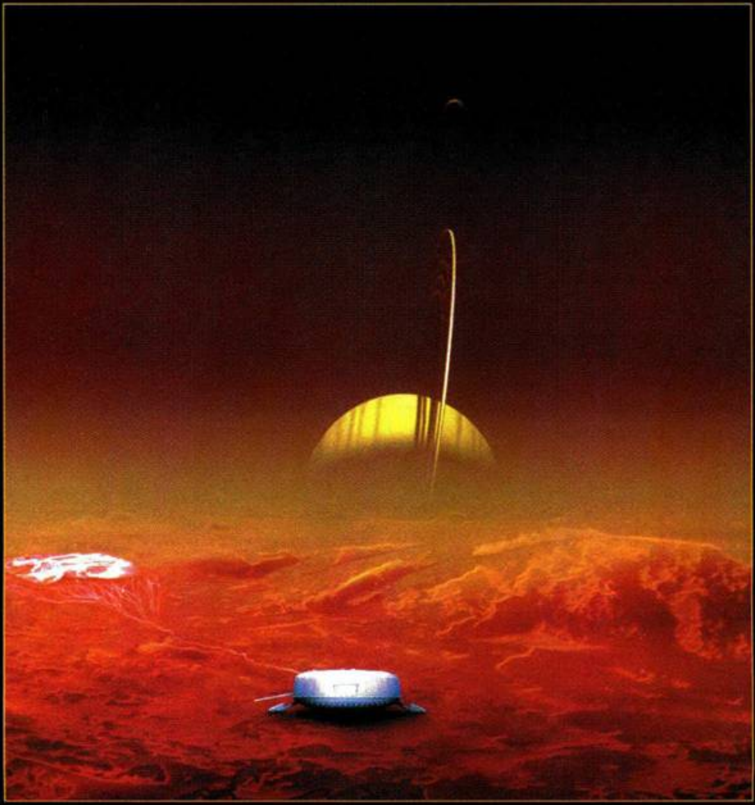
Next Stop: Saturn

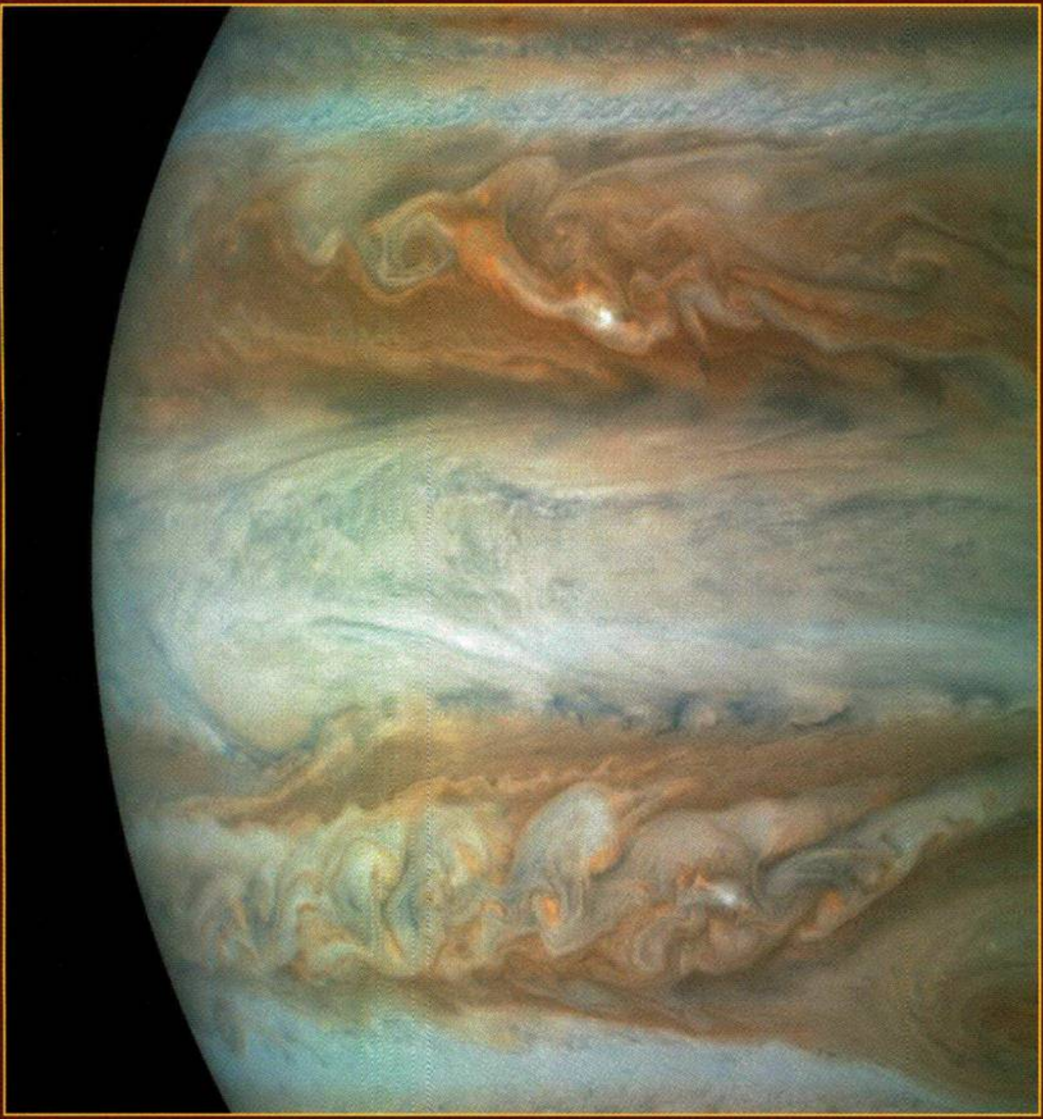
Watching Cassini perform its magic at Jupiter has only served to whet the appetites of planetary scientists. The mission's real payoff comes in 2004, when the spacecraft goes into orbit around Saturn. From the time it arrives on July 1 and for the next four years, Cassini will scrutinize the planet's atmosphere as well as the rings and the multitude of moons (which number 30 at last count). In all, the camera should return more than 300,000 color images.

Tucked inside the Cassini orbiter is the Huygens probe — a robotic laboratory supplied by the European Space Agency (ESA) that's designed to study the clouds, atmosphere, and surface of Saturn's largest moon, Titan. Scheduled to reach Titan on November 27, 2004, Huygens will deploy a parachute and descend through the moon's atmosphere, which is thicker than Earth's. Instruments will measure the atmosphere's temperature, density, pressure, and composition, and a camera will snap a thousand or more images.

Yet there's a dark cloud now hanging over Huygens. A communications test last year found a problem that could prevent the probe from relaying some of its data to the orbiter (which then sends it on to Earth). Although it's too early to know for sure, some scientists think more than half the data could be lost if the problem is not corrected.

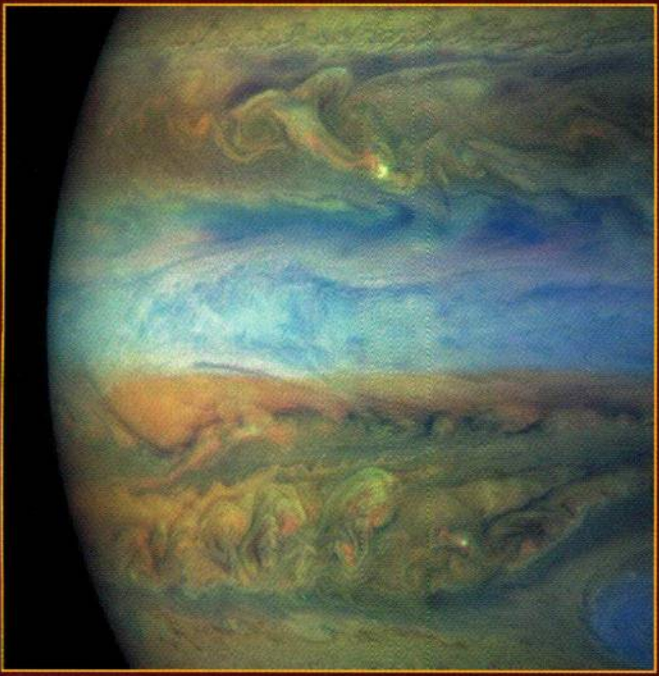
NASA and ESA are working on possible solutions. Among the options being discussed are raising the orbiter's altitude as it flies over Titan, having the probe descend through the atmosphere faster, or reducing Cassini's speed during the descent. Unfortunately, all the choices would affect the orbiter's mission as well, so there's a tradeoff involved. A decision could come as early as this summer. — *R.T.*





On the last day of the old millennium, and just one day past its closest approach to Jupiter, Cassini captured the equatorial region of Jupiter. The image at left shows a true-color view of the planet that matches what the human eye would see.

The false-color view below was taken through three different filters that help emphasize the heights of different cloud layers. Red regions show water clouds deep in the atmosphere while the bright blue regions represent high haze (which covers the Great Red Spot at lower right). The small, bright white spots are energetic lightning storms that have penetrated high into the atmosphere.



When Yuri Took Flight

Forty years ago, Russian Cosmonaut Yuri Gagarin became the first human in space and an icon for the ages.

by Jim Schefter

The Cold War, a Communist threat from Cuba, and an unlikely Soviet hero were forever conjoined in the annals of history 40 years ago. It was a time of rapid social and political change: The Twist, the birth-control pill, and anti-segregation protests in the South had burst upon America's cultural consciousness. On April 12, 1961, newly elected President John F. Kennedy was concentrating on a surprise invasion of Cuba by U.S.-supported counter-revolutionaries, when a daring cosmonaut jolted the world. Yuri Gagarin soared 200 miles overhead, becoming the first human in space and the first to orbit the planet. While Gagarin's flight lasted only 1 hour and 49 minutes, it became one of the century's most significant human achievements.

The United States lost the early heats in the space race and Kennedy was blamed for failing to dislodge Cuban dictator Fidel Castro from power. American newspapers and magazines glorified U.S. astronauts-in-training; however, the Soviet Union's manned space program remained a state secret — until Gagarin's amazing deed. His flight opened a frontier in space that continues to enlarge.

Yuri Gagarin, an improbable hero, became an international sensation after his 1961 space flight. Owen/Black Star

Bettmann/Corbis

Riding a bus to the waiting Vostok 1 rocket, Gagarin's face becomes a study in fear and determination.

The first evidence that the Soviet Union even had such a program appeared in an announcement posted on bulletin boards in Red Air Force ready rooms in October 1959. Soviet officials were asking for volunteers. To most of the pilots, it sounded like a joke: The idea of giving up their careers as hotshot pilots of some of the world's fastest and most agile combat jets was ludicrous. Most rolled their eyes and chuckled, but a few took it seriously: The looks in their eyes were of wonder and excitement.

The guffaws soon subsided. The list of applicants quickly grew to 3,500. Boxes of letters lined a narrow hallway in an obscure building in a drab Moscow suburb. Clerks and engineers sorted through the letters for their autocratic boss, a man known to the outside world only as the Chief Designer.

Frozen in Fear

Months later, the Chief Designer — the West wouldn't know he was Sergei Korolev until after his death in 1966 — picked six candidates. Valeri Bykovsky, Gherman Titov, Grigory Nelyubov, Andrian Nikolaev, Pavel Popovich, and Yuri Gagarin were to report for cosmonaut training.

The man who would outdo the rest was 5-foot-6, thin, and 25 years old. In the beginning, Gagarin was nobody's image of a hero. He was too small and too plain, perhaps a result of being undernourished while growing up during World War II. He was from Klushino, a town in a flax-growing region in western Russia overrun by the German Wehrmacht. Gagarin was educated as a metalworker at an obscure technical college and taken into the Air Force to fulfill his military-service requirement.

Gagarin prepared well. While still in school, he qualified for pilot training with male and female classmates at a flying club. In 1955, as the future cosmonaut prepared to make his first parachute jump, he stood frozen in fear on a wing strut. According to a later account, Gagarin didn't budge until an instructor loudly reminded him that the girls were watching. Red-faced at his own hesitation, Gagarin let go and fell into his life's most important turning point under a billowing white canopy.

From that moment, metalworking faded from Gagarin's dreams in favor of flying airplanes and jumping from them. He finished his flying courses in 1956. His reflexes and coordination made him one of the best in Air Force flight school, but he needed a seat cushion in his Yak trainer to see downward enough to land. Sputnik 1, the first man-made satellite to go into orbit, chirped a signal for all to hear in October 1957, just before Gagarin graduated.

For Gagarin it was an exciting time to be young and strong and to feel the powerful thrust of a jet as it sent him skyward. But fate was aiming him even higher. Gagarin and his girlfriend, Valya, were married on the day that Sputnik 2 reached orbit with the dog Laika aboard. When Valya returned to nursing school in Moscow, her husband was assigned to a base near the Arctic Circle, which was the front line of Soviet air defenses.

With the shimmering Northern Lights as a backdrop and little to do but read and fly, Gagarin contemplated space. He later told William Shelton, a reporter for *Life* magazine, that he made notes to himself in the margins of *Pravda* after Sputnik 3 was launched. When Nikita Khrushchev, the premier of the Soviet Union from 1958 to 1964, said that the time for man in space had not come, Gagarin simply wrote, "I never doubted that I would apply for space flight."

He got his chance that October, just after the Soviet Luna 3 satellite photographed the farside of the moon for the first time. Korolev was ready to train his cosmonauts. The Chief Designer didn't require test pilots, because the occupant of his space capsule wouldn't maneuver it. Nor did Korolev need engineering or design skills: Others would handle those chores. Korolev simply wanted a superb physical specimen, a human that could survive a rocket launch, zero gravity, and reentry through the atmosphere. Beyond that, he wanted a passenger who would do as told.

Korolev didn't care if his cosmonauts were smart. (Although all of them were.) Gagarin's sharp intellect made him stand out, and during slow moments in training — "hurry up and wait" was not confined to the American military — he was apt to discuss rocketry or aeronautical theory. When Korolev asked his cosmonauts to evaluate each other, the written comments described Gagarin as decisive, bold, and steadfast. Three of Gagarin's peers thought he should be first to go into space.

While American astronauts in 1960 helped design and build their Mercury capsules, Korolev's cosmonauts were kept away from the Soviet designers. They were briefed about size and interior configurations, but there was no discussion of engineering details. Cosmonauts flew jets and practiced parachuting. Over farmers' fields along the Volga River, Gagarin became an expert in free-fall jumping and accurate landing. To increase their stamina, they ran for miles and practiced gymnastics.

Korolev also confined them to sensory-deprivation chambers to mentally challenge them. First for hours and later for days, each cosmonaut was locked in a dark, soundproof chamber until his consciousness merged into nothing but the spark of life. They were spun in whirling centrifuges, shaken on vibration stands, and roasted and froze — all part of training that was a clue about what was to come.

A Lucky Break

The training remained secret. While the American media lionized Shepard, Glenn, and the other Mercury astronauts, the Soviet press never mentioned cosmonauts. Korolev ordered Gagarin and his fellow trainees not to tell their families about his man-in-space plans. Valya suspected the truth and one day tricked her husband into telling her as much. By then parents to a baby girl, they were so horrified at the intrafamily security breach that neither mentioned it again.

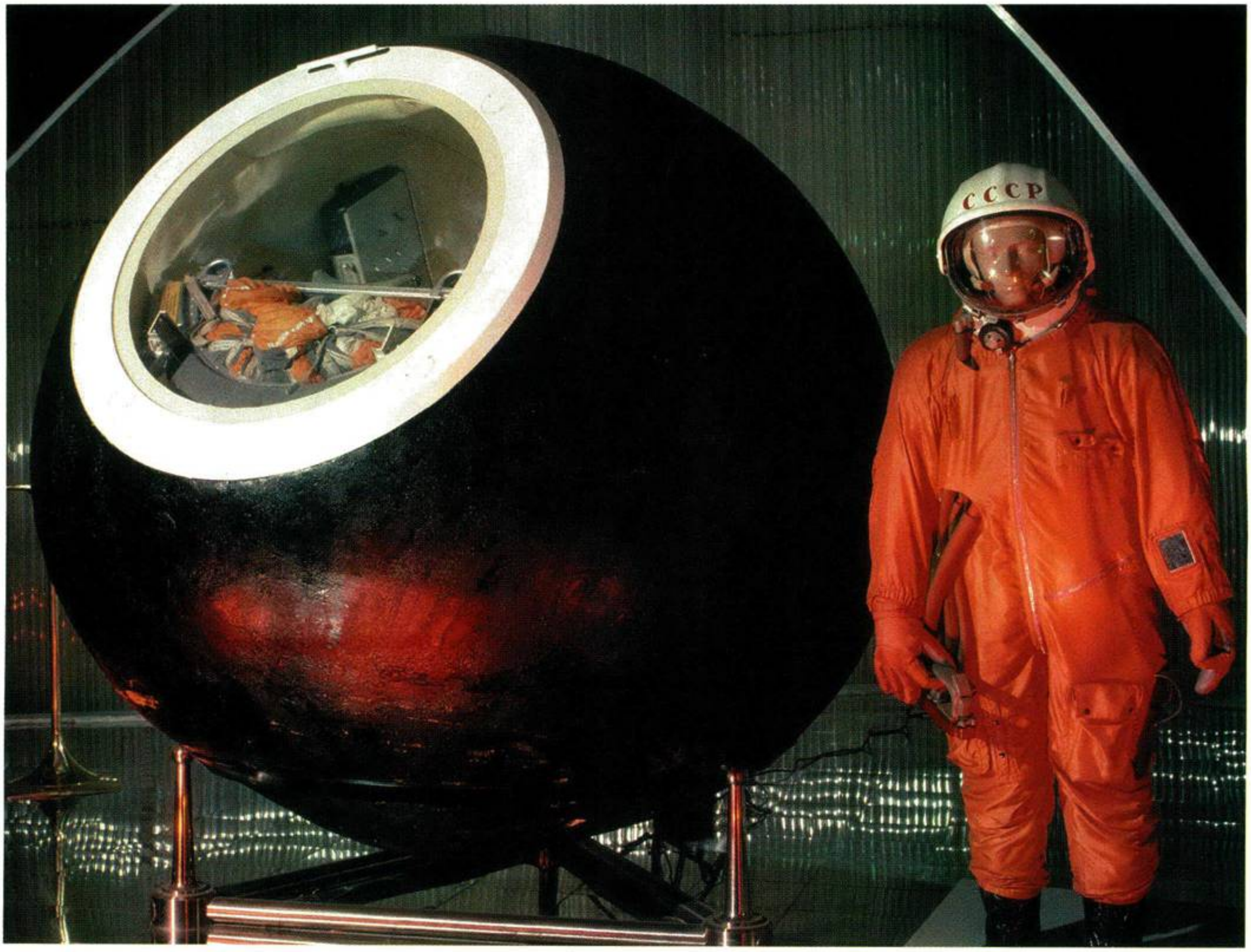
The Chief Designer's penchant was clear. The Soviet Union had beaten America with unmanned satellites and Korolev wanted to do the same with a cosmonaut. He received unexpected help from Wernher von Braun. He was a German-born U.S. rocket engineer who was instrumental in the design of German rocket weapons during World War II. Near the end of the war von Braun surrendered to Allied forces and later became a prime mover in the early days of space rocketry in the U.S. One of von Braun's Redstone rockets was to send American astronaut Alan Shepard on a suborbital space flight on March 25, 1961. The date was no secret, awaiting one more successful Mercury-Redstone test on January 31. In the test flight, a chimpanzee named Ham performed his manual dexterity chores well and survived his flight in fine physical shape. Though Ham's mission went well, his ride was rougher than expected. (See "Reluctant Astronauts," page 42.)

Good enough, said many of the engineers working on Project Mercury.

Not good enough, said von Braun. He feared the Redstone engines were too powerful for a manned mission, and he demanded another test. Another Redstone flew in March — a perfect launch with neither animal nor astronaut aboard. Shepard's trip would wait until May.

Korolev saw the Mercury delay as a lucky break. Some of his rockets failed. Guidance systems put test ships and their dog passengers into the wrong orbits or incinerated them on reentry. He finally got two successful launches in a row and ordered a third rocket and a Vostok capsule for liftoff no later than mid-April.

The hatch on the Vostok space capsule, shown in a museum display, blew off prematurely, but Gagarin parachuted safely to the ground.



Roger Ressmeyer/Corbis

The Chief Designer's Pick

Now came the final question: Who would ride in it? The six well-tested cosmonauts were physical marvels, but only one could go. Korolev sat down with them on April 8 and grilled them all day and into the evening. As each answered questions or responded to gruff challenges, Korolev looked for any sign of weakness. Finally, he went back to his spartan room at the Baikonur launch facility and considered each candidate. Then he called his team together to announce his decision: Gagarin would ride the rocket. If something happened, Titov would be the backup. American astronauts later called Titov "Herman" and considered him a friend. "Herman was really upset at being second," Apollo 12 astronaut Dick Gordon told me recently. "He was always convinced that he was the best man."

The dour Korolev took Gagarin and Titov into isolation on the afternoon of April 11. In uncharacteristic fancy, he told Gagarin that his flight would lead to resorts in space in five years. Later that night, he crept into Gagarin's bedroom to verify for himself that his iron man was sleeping soundly.

A few hours later, Korolev stepped from a blue and white bus and helped Gagarin, clad in a bright orange space suit, to the ground. The rocket had arrived at the launch pad by rail and Gagarin began a tradition followed by cosmonauts to this day. He walked to the track, opened his suit, and relieved himself on the wooden ties. Korolev grinned and joined him.

The rocket's strap-on engines fired at 9:06 A.M. Moscow time on April 12. The rumble and vibration shot up Gagarin's spine. His rendezvous with history had arrived. His famous first yell was "*Poyekali!*" — Let's go!

Within minutes the Vostok 1 spacecraft was in space. Gagarin recorded most of his comments on tape. Weightlessness was a lightness in the limbs. He watched a bead of water float through the air and settle on the porthole of his spherical spacecraft. Beyond the thick glass, he looked up at the cosmos and down on a planet. "The sky is very dark; the Earth is bluish. Everything is seen very clearly." Communist commissars worried that cosmonauts might fire retrorockets early and defect to the West. Gagarin wasn't tempted.

About 78 minutes after liftoff, the retrorockets fired automatically, starting the spacecraft down. That was when trouble started. The retro pack didn't separate. With the spacecraft's aerodynamic stability gone, it wobbled and shook uncontrollably. Inside, Gagarin was jostled and battered, but he stayed calm. Finally the retrorockets burned loose and the wobble slowed. Then, something occurred that the Soviets would keep secret for decades.

At an altitude of 23,000 feet, Vostok's hatch blew away. Gagarin activated his ejection seat and was jettisoned clear of the capsule. Cosmonaut and spacecraft floated under sepa-

The cosmonaut receives a bouquet of flowers from a girl at the Soviet Embassy during his 1961 visit to London.

Hulton-Deutsch Collection/Corbis

NASA

A Marine helicopter crew plucks Mercury astronaut Alan Shepard from the Atlantic after his suborbital flight on May 5, 1961.

rate parachutes. On the way down, Gagarin spotted familiar landmarks along the Volga River. It was where he had made so many training jumps.

Inspiring Lunar Dreams

The Soviets implied that Gagarin rode Vostok to the ground. Under international rules set by the Federation Aeronautique International (FAI), which certifies flight records, a pilot must stay with his craft from takeoff to landing before any record is ratified. If the world knew that Gagarin had bailed out, Korolev worried that he might not get credit for being the first man in space.

Korolev was too pessimistic. Gagarin was an immediate worldwide celebrity. No one would question his Earth-orbiting accomplishment because he traveled the last 23,000 feet under silk. But the fiction that he had remained in the capsule endured into the 1980s.

After he landed, the first helicopter officer to reach Gagarin saluted him and called him "Major." Lieutenant Gagarin had been promoted, skipping the rank of captain completely, as he circled Earth.

April 12, 1961, was a momentous day. Man had ventured into space and returned alive. History notes that the spaceman was Russian. It also notes that he was merely human and that his adventurous species had taken its first small step from the planet. In the year when Khrushchev built the Berlin Wall and Camelot encompassed Kennedy, the human race levitated gracefully on the shoulders of an unlikely Russian. American astronaut Alan Shepard flew briefly into space a couple weeks later and President Kennedy later stood before Congress and promised that America would send men to the moon "before the decade is out."

Neither Kennedy, who was assassinated in 1963, nor Gagarin lived to see the lunar promise fulfilled. When the hero worship began to fade, Gagarin went to test-pilot school and was killed when a high-performance MiG jet fighter he was flying went down in 1968. His ashes were interred in the Kremlin Wall close to those of his mentor, Korolev, who had died two years earlier.

I was in Moscow in March 2000, one of the first American journalists invited to inspect once-secret Russian rocket factories. I went to the Kremlin and a guide understood me well enough to point out Gagarin's resting place in the wall. I looked through my binoculars at a plaque that marks the entombed remains of the person who was the first to see a bluish planet from above. ■

Jim Schefter has covered space flight since 1963 for Time, Life, *and* Popular Science, *and is the author of* The Race: The Uncensored Story of How America Beat Russia to the Moon.

Reluctant Astronauts

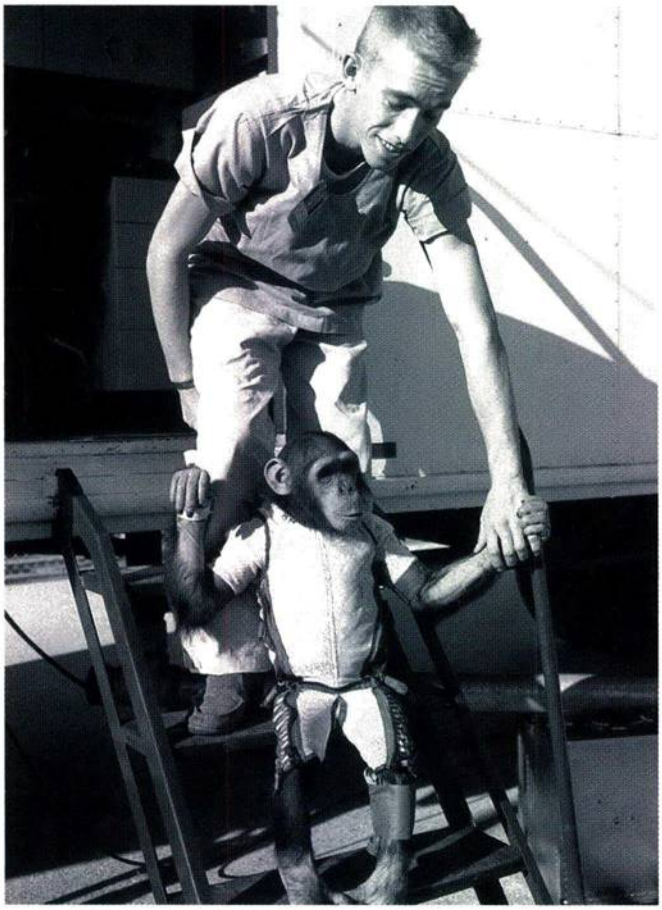
How other creatures paved the way for human space travelers.

by Kelly Kizer Whitt

The first living beings in space were not brave and heroic men. They were hapless animals that gave their lives for the advancement of the world's space programs. The first successful mission (as in an animal returned alive to bark again on Earth) occurred 50 years ago in 1951. Man's closest kin, the monkey, was the first being to ascend beyond Earth's protective ozone layer into the mesosphere, and man's best friend, the dog, was the first to orbit Earth in a rocket. Many other animals also went into space, from mice to chimps, while others, like the French-trained space cats, only prepared.

People remember the names Yuri Gagarin and Alan Shepard, but most forget that the humans who went into space depended on other animals that tested conditions in space that couldn't be replicated on Earth before the 1960s. Sam, Ham, and Laika, names that probably ring no bells for you, flew to

A Rhesus monkey is fitted for its netlike spacesuit prior to a space journey in Project Mercury's Little Joe test capsule. Bettmann/CORBIS



NASA

A chimp suits up for a 30-mile flight in a Mercury-Redstone 2 rocket. MR-2 was one of several launches to prepare for orbital flight.

space mainly to see how weightlessness would effect living organisms, but also to see how the stress of space travel would affect behavior. The future of the human space program depended on these animals and their ability to survive and thrive. Laika, Albert, Pchelka, Mushka, and Gordo are just a few of the animals that paved the way for humans to enter into the "final frontier." Yuri and Alan (and the rest of us) owe them all a huge debt of gratitude.

Monkey Flights

The beginning of the space age is often considered to be the launch of Sputnik in 1957. However, trips into space began more than 50 years ago. Before the creation of NASA, the United States Air Force carried out space-flight experiments. In 1949, V-2 rockets shot live Air Force Aero Medical Laboratory monkeys into the high reaches of the atmosphere to test how primates could withstand spacelike conditions. In separate trips, the monkeys, named Albert I, II, III, and IV, rode in the nose cones of the rockets. Naming the first monkey Albert was a humanizing gesture; however, he did not survive the trip. Albert's successors were then named after him and numbered in a less personal way, and they suffered his same fate. While all the monkeys survived the trip up, showing no ill effects, the return parachutes failed to open, killing the travelers on impact.

A couple years after these semisuccessful V-2 flights, the U.S. Air Force accomplished the first animal launches that ended with a live occupant. On September 20, 1951, an Aerobee rocket blasted off from Holloman Air Force Base in New Mexico, carrying a monkey named Yorick and 11 mice. The trip reached a height of 45 miles (236,000 feet), and the creatures onboard were recovered alive, despite the literary allusion of the monkey's name, which would suggest the expectations for the animals had not been good. (In Hamlet, Act V, Scene 1, Hamlet finds his friend's skull and says to Horatio, "Alas, poor Yorick! I knew him well.")

The Air Force completed its last launch with an Aerobee rocket on May 22, 1952. This time the passengers consisted of two mice, Mildred and Albert, and two Phillipine monkeys, Patricia and Mike. They were sent 36 miles up and viewed with an onboard video camera to observe the effects of acceleration, weightlessness, and deceleration. The two mice floated in their holding drum when they reached the period of weightlessness. To measure the effects of the 2,000-mile-per-hour acceleration, Patricia was strapped in a seated position, while Mike was supported in a prone position. The animals all survived the flight and parachute landing. Their successful mission garnered Patricia and Mike a spot at the National Zoological Park in Washington, D.C., where they lived out the rest of their lives.

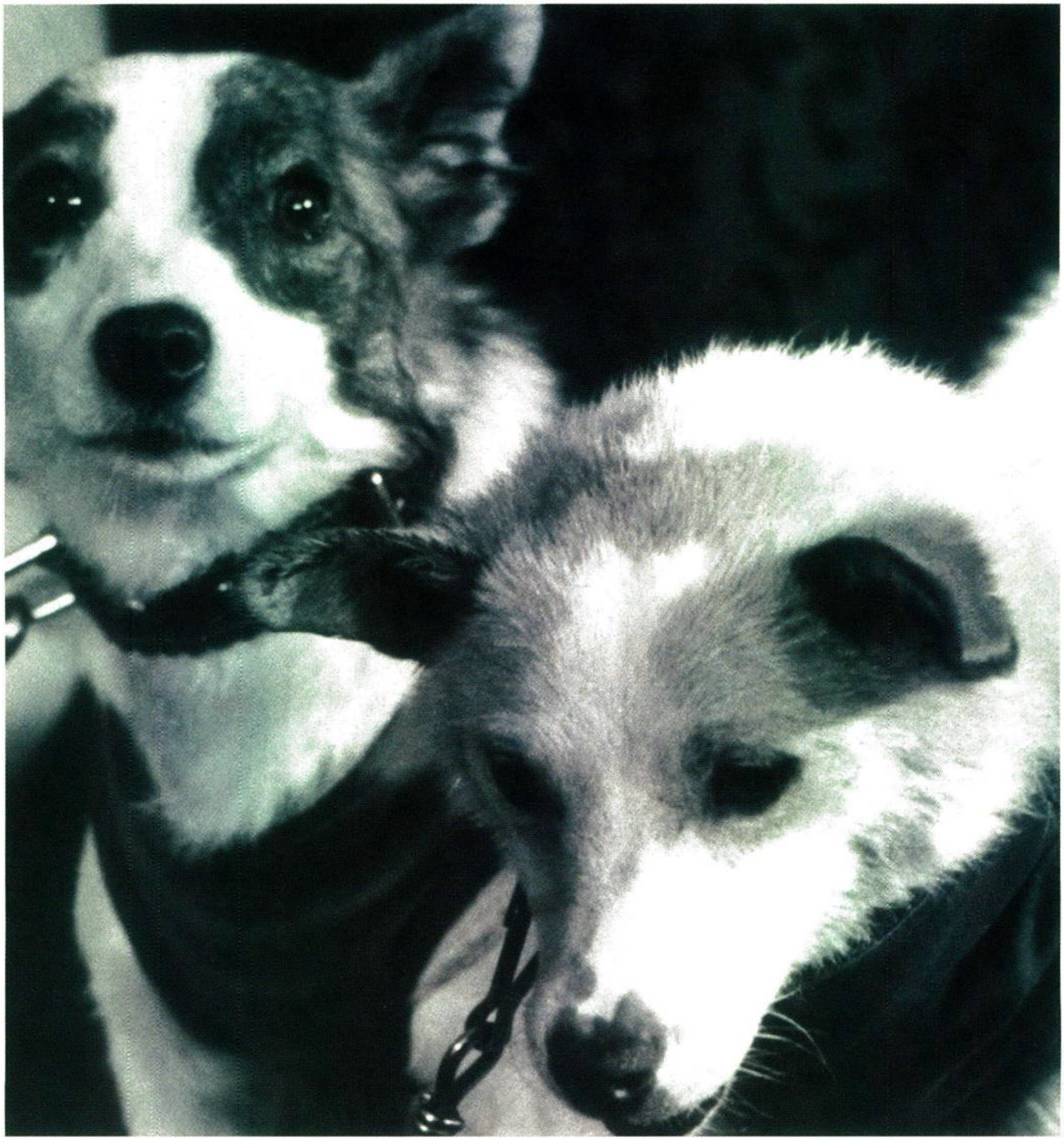
Around this time, our early tests of sending live passengers to the edge of space took a 6-year hiatus as the military focused on missiles and other defense developments. Meanwhile, the U.S.S.R. was practicing to send a dog into orbit around Earth. Testing, using nine canine cosmonauts, or Soviet "Space Dogs," included the use of space suits in unpressurized cabins. Albina and Tsyganka were two such Soviet dogs who flew upward to the limits of Earth's atmosphere and were ejected during the descent at 53 miles (85 km) up. The two rode safely back to Earth on their ejection seats. The Soviet's vertical animal launches peaked at about 300 miles. These were all in preparation for the world-shaking feat that was to come in 1957, with the launch and orbit of Sputnik 1 and Sputnik 2.

Laika

By 1957, the Soviets had assured themselves that spaceflight was possible for Earth's living inhabitants, and they were ready with their satellites to send a living creature into orbit. Following the launch of the world's first artificial satellite, Sputnik, on October 4, 1957, they launched Sputnik 2 on November 3, 1957. Inside the cabin was the first live space traveler, Laika, a stray husky picked up off the streets of Moscow. The Soviets were first introduced to the little dog at a press conference on October 27, when she barked into a microphone at a radio broadcast. Laika, which means "Barker" in Russian, was nicknamed Muttnik by the American press.

Laika rode in a 1,120-pound vehicle with a variety of scientific gauges, life-support systems, and padded walls. A harness system held Laika in place but allowed access to food and water. Scientists groomed the little mutt before launch and attached electrodes to shaven areas to record vital signs of blood pressure, heartbeat, and breath frequency.

Sputnik 2 was carried into space by an SS-6 rocket from the Baikonur Cosmodrome. The satellite ascended nearly twice as high as Sputnik 1 (to 1,038 miles or 1,671 km), but Laika suffered no ill effects. While weightless, Laika could eat, drink, bark, and move around, although limited by her harness. But because the satellite was not designed to return safely to Earth, the rest of Laika's story is subject to debate



Bettmann/CORBIS

and speculation. Most estimates claim that Laika lived between 4 and 10 days in orbit. Some suggest that her last bit of food may have been poisoned. Others claim that she was gassed or that she succumbed from a lack of oxygen when the life-support system batteries ran out. In any case, Sputnik 2 remained in orbit for 163 days, completing 2,370 orbits as it circled Earth every 1 hour and 42 minutes. Laika's orbiting coffin finally fell and burned up in the atmosphere on April 14, 1958.

In Star City, outside Moscow, a monument to honor fallen cosmonauts was erected 40 years after Laika's spaceflight. It includes an image of her peeping out from behind the cosmonauts.

Russian space dogs Belka and Strelka went into space on Sputnik 5 and returned healthy. Sometime after her trip into space, Strelka gave birth to six puppies, one of which was given to President John F. Kennedy.

U.S. Monkeys Return to Space

America returned to practicing for spaceflight using animals as "guinea pigs" after the Laika incident. On December 13, 1958, the U.S. Army launched Gordo the squirrel monkey aboard a Jupiter AM-13 booster into suborbital flight. The monkey did fine physically during the flight; however, the recovery, involving a flotation mechanism in the rocket's nose cone, failed, and Gordo perished.

About six months later, the United States tried again, this time launching two monkeys, a female rhesus named Able and a female squirrel monkey named Baker, aboard a Jupiter AM-18 rocket into suborbital flight. The monkeys flew to a height of 300 miles up and traveled at over 10,000 miles per hour. After experiencing 9 minutes of weightlessness, the monkeys were successfully recovered alive. The sensors that were used to transmit data on the monkeys' vital signs were removed in surgery after the flight. Unfortunately, Able died from the anesthetic administered in that operation.

Sam and Miss Sam were rhesus monkeys launched into space aboard Little Joe animal flights. Sam went first, on December 4, 1959, traveling 55 miles into space. His flight was a test of the couch and restraint apparatus that would be used as protection against high accelerations in future Mercury flights. Sam was recovered alive by the USS *Borie* in the Atlantic Ocean off Cape Hatteras, North Carolina. His trainers reported he happily embraced Miss Sam immediately on his return to the lab. Miss Sam journeyed into space the next month, on January 21, 1960, traveling only 9 miles up for 58 minutes to test the escape system of later Mercury manned flights. Miss Sam was also recovered alive in the Atlantic Ocean, by a Marine helicopter.

More Dogs in Space

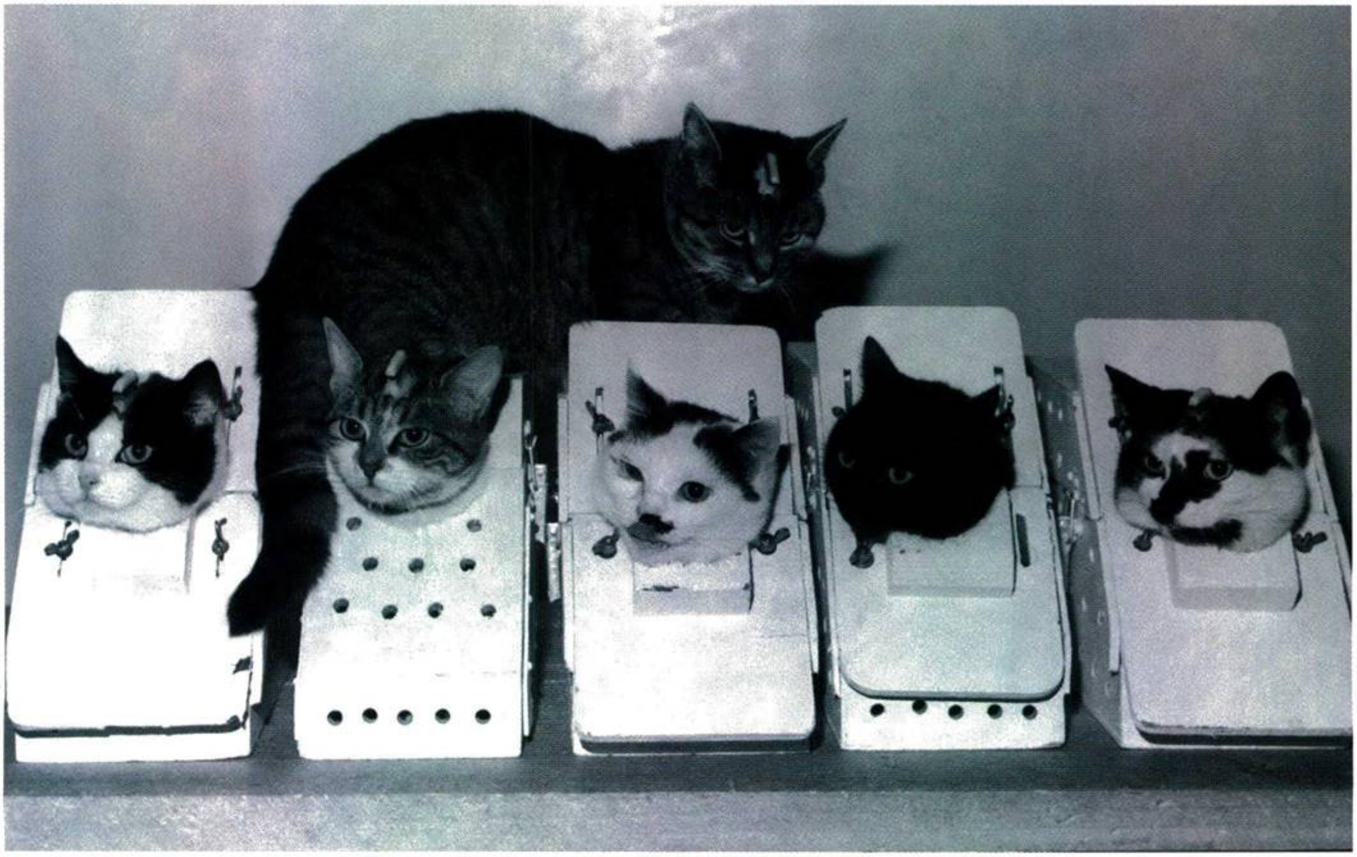
After the orbit of Laika in 1957, the Soviets did not attempt to return another dog to space until July 28, 1960. The mission was to be a test flight of the Vostok spacecraft. Two dogs, Bars (Lynx) and Lisichka (Little Fox), were killed when the booster rocket exploded during launch.

Finally, on August 19, 1960, the dogs Belka (Squirrel) and Strelka (Little Arrow), along with 40 mice, 2 rats, and 15 containers of fruit flies, were launched into orbit on Sputnik 5. The occupants spent one day in orbit before the capsule separated and parachuted to Earth within 6 miles from their target landing zone. The landing, although a hard one, marked the first time living creatures had flown in space orbit and returned safely to Earth. Strelka eventually gave birth to a litter of 6 puppies, one of which was given to President Kennedy as a gift.

Two more flights with canine cosmonauts were launched in December of that year. On December 1, 1960, Sputnik 6 orbited Earth with its passengers, the space mutts Pchelka (Little Bee) and Mushka (Little Fly). After a day in orbit, the retrorocket fire to return the animals to Earth was improperly performed, and the capsule's reentry came at too steep an angle, causing the onboard passengers to be burned alive. Weeks later, on December 22, the Soviets tried again with dogs named Damka (Little Lady) and Krasavka (Beauty) on another Sputnik craft. This time, the booster's upper rocket stage failed and the flight was aborted; fortunately the animals were rescued after their unplanned suborbital flight.

Soviet Dogs and U.S. Monkeys Share Space

On January 31, 1961, a chimpanzee made yet another suborbital flight for the Americans. Ham flew in a Mercury spacecraft with a Redstone booster rocket as the launch mechanism from Cape Canaveral, Florida. The four-year-old chimp practiced with three other chimps for his trip into space by learning to pull a series of levers, after which he would be rewarded if he made the right choices. This chore was to prove that the living occupants onboard a spacecraft



Cats train for space travel planned by the French government in 1973. The enclosures are meant to simulate spacesuit confinement.

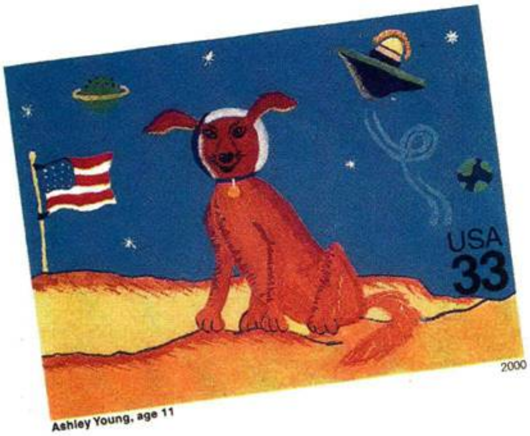
Hulton-Deutsch Collection/CORBIS

CONTINUING TRIBUTES

Astro-Dog Stamps

Almost immediately, Eastern bloc countries began issuing stamps honoring the Soviet space dogs. In 1957 Laika appeared on a Romanian stamp, again on an Albanian stamp in 1962 and a Polish stamp in 1964. The U.S.S.R. issued stamps for Strelka and Belka in 1960 and one for Zvezdochka and Chernushka in 1961. Bulgaria issued stamps for Strelka and Belka and another with Strelka, Belka, Chernushka, and Zvezdochka in 1961. Sharjah/Mongolia issued a stamp for Laika in 1963, as did Hungary. In 1965 Ascension Island issued a Laika stamp, as did North Korea in 1987.

The U.S. Postal Service has recently issued a collection of stamps created from drawings by children who dream of future space travel. The stamp shown here inadvertently honors the memory of former space travelers.



The Laika Foundation

The Laika Foundation was created in Russia to provide lifelong care for the space program's retired animals. After the last animal astronaut died in 1978, the group began funding scientific research.

Save the Chimps

Although, as mentioned, some of the famous chimpanzee astronauts were retired to zoos upon completion of their duties, many other chimps were trained and prepared for spaceflight but never took the journey. These chimps were used in other experiments, such as seatbelt testing, and in the 1970s, the Air Force began leasing the chimps for biomedical research. In 1997 the Air Force decided to discharge the animals from duty. However, many of them were given to the Coulston Foundation, a research laboratory that has been criticized for its poor care and investigated for violations of the federal Animal Welfare Act.

In 1998, the Center for Captive Chimpanzee Care, begun with the help of Jane Goodall and Doris Day, submitted a proposal to move 142 chimps to its sanctuary. The Texas Center lost its bid, but won the support of many famous human astronauts, including Buzz Aldrin, Scott Carpenter, Gerald Carr, Eugene Cernan, Gordon Cooper, Walter Cunningham, Michael Collins, Jack Lousma, James Lovell, and James McDivitt. Eventually, the Center filed suit against the Air Force. In 1999 the two groups settled and the Center won custody of 21 chimpanzees, and brought them to its Florida sanctuary.

NASA's Pets in Space Essay

You may write an essay to nominate your pet for future space missions with NASA. For more information, go to www.Astronomy.com.

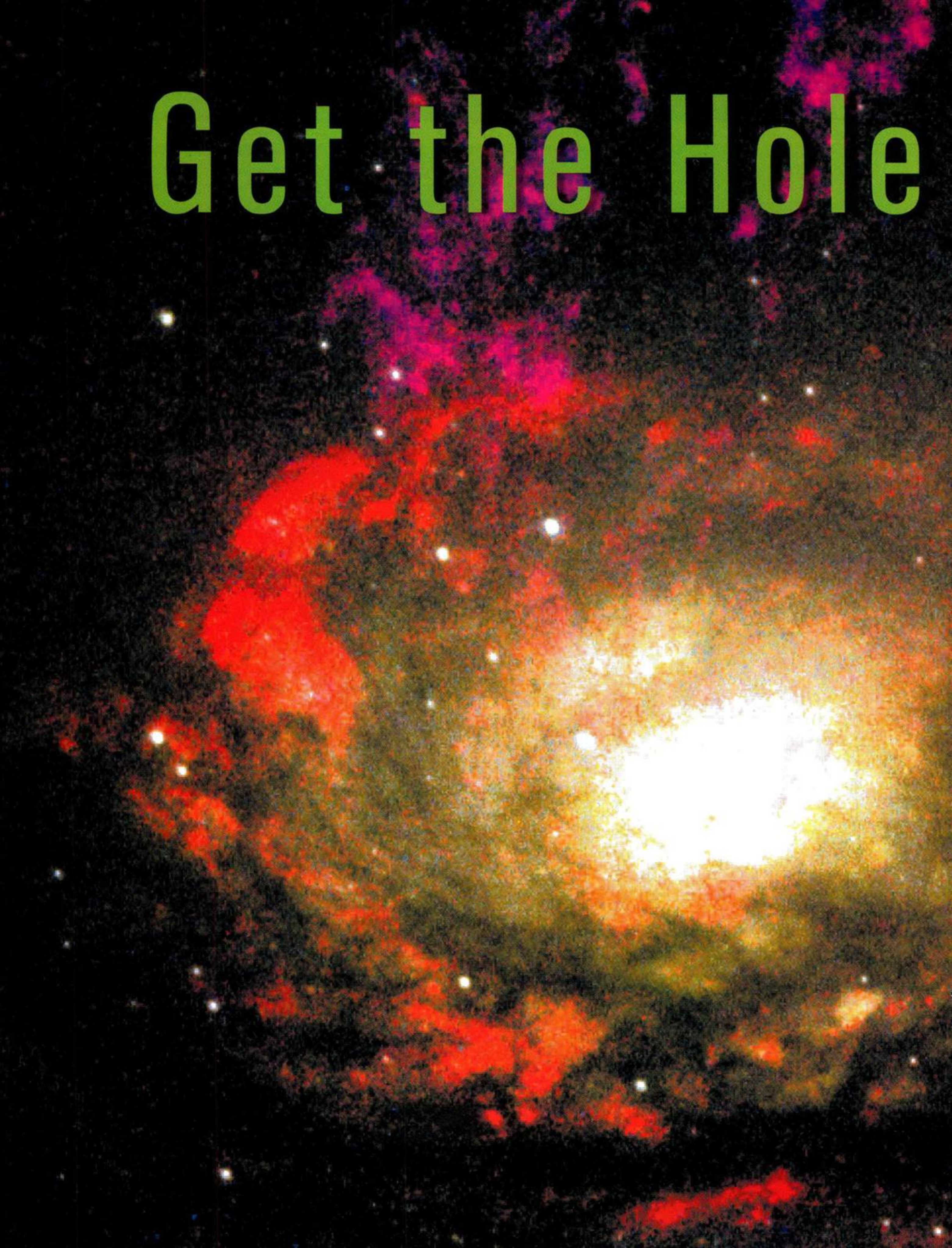
could still function in their jobs during launch, weightlessness, and reentry. The spacecraft malfunctioned, though, reaching a speed of 5,857 mph, which was 1,457 mph faster than had been planned. The extra speed caused the spacecraft to experience 1.7 minutes more weightlessness than projected (6.6 minutes total) and shot the craft 122 miles off course. Despite these difficulties, Ham was able to perform his tasks nearly perfectly. His capsule landed in the Atlantic Ocean at about 12:12 P.M., far from the predicted landing spot; therefore, no craft was available to rescue him. The spacecraft was battered by waves and lying on its side, taking on water and submerging when it was finally found by helicopter pilots. By 2:52 P.M. a helicopter managed to latch onto the craft and lift it from the sea. Unbelievably, Ham survived the rocky space mission in good condition and was retired to the National Zoological Park in Washington on April 2, 1963. His remarkable journey and ability to survive adverse conditions gave Americans confidence enough to send up a human, Alan Shepard, on a suborbital flight on May 5, 1961.

Meanwhile, back in Russia, more dogs were paving the path for the first orbit by a human. A black dog named Chernushka (Blackie), along with a dummy cosmonaut, mice, and a guinea pig, rocketed into space aboard Sputnik 9 on March 9, 1961. Just weeks later, on March 25, 1961, the cosmodog Zvezdochka (Little Star) and another wooden mannequin made an orbit, successfully paving the way for Yuri Gagarin. Gagarin became the first man in space on April 12, 1961, spending 108 minutes orbiting in Vostok 1.

Not until late in 1961 did the United States finally manage to send a living being into orbit. On November 29, 1961, Enos became the first chimp in space. Enos blasted off in the Mercury Atlas 5 rocket and made two orbits before being brought down one orbit early because the spacecraft was not performing exactly as planned. Enos also had "jobs" to do during his flight, which he performed successfully. Following Enos's flight on February 20, 1962, John Glenn became the first American to orbit Earth.

When humans began to fly into space, animal astronauts were no longer so necessary to the program. Some animals have been sent skyward since the 1960s, particularly those who paved the way for a mission to the moon and long-duration spaceflight aboard Skylab. They served as stand-ins for humans and proved to the world that spaceflight was possible. Without the efforts of Laika and Miss Sam, Yuri and Alan would probably be unknown. ■

Get the Hole



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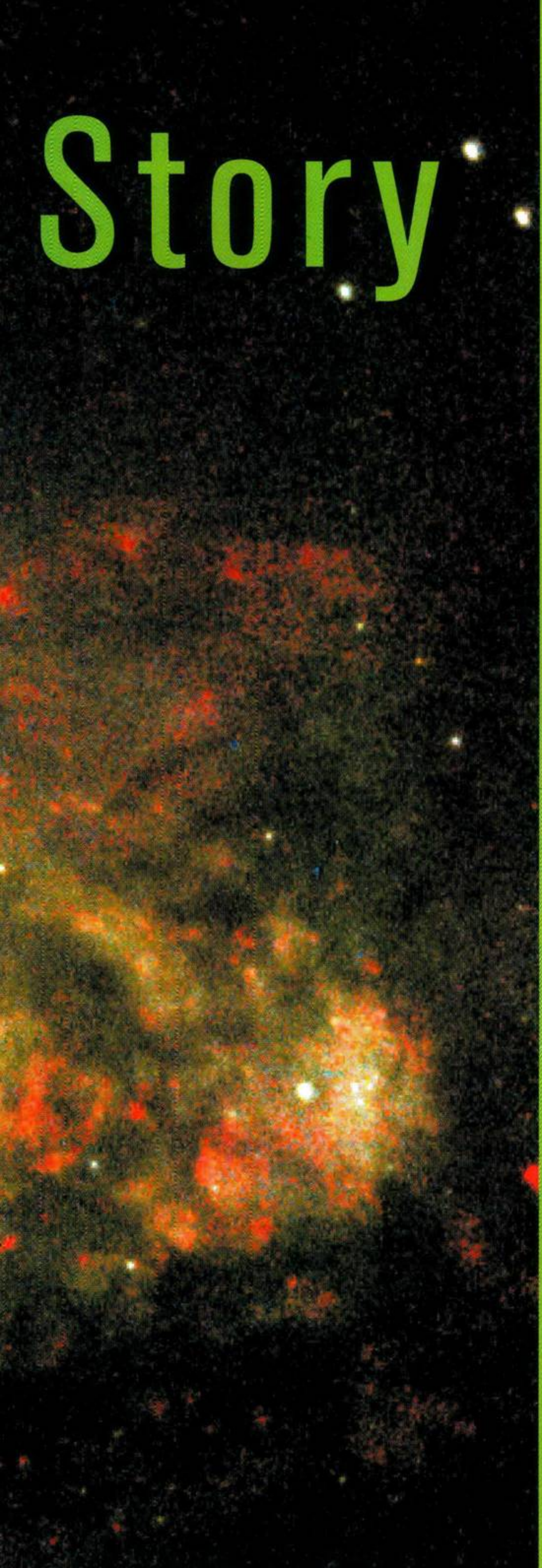


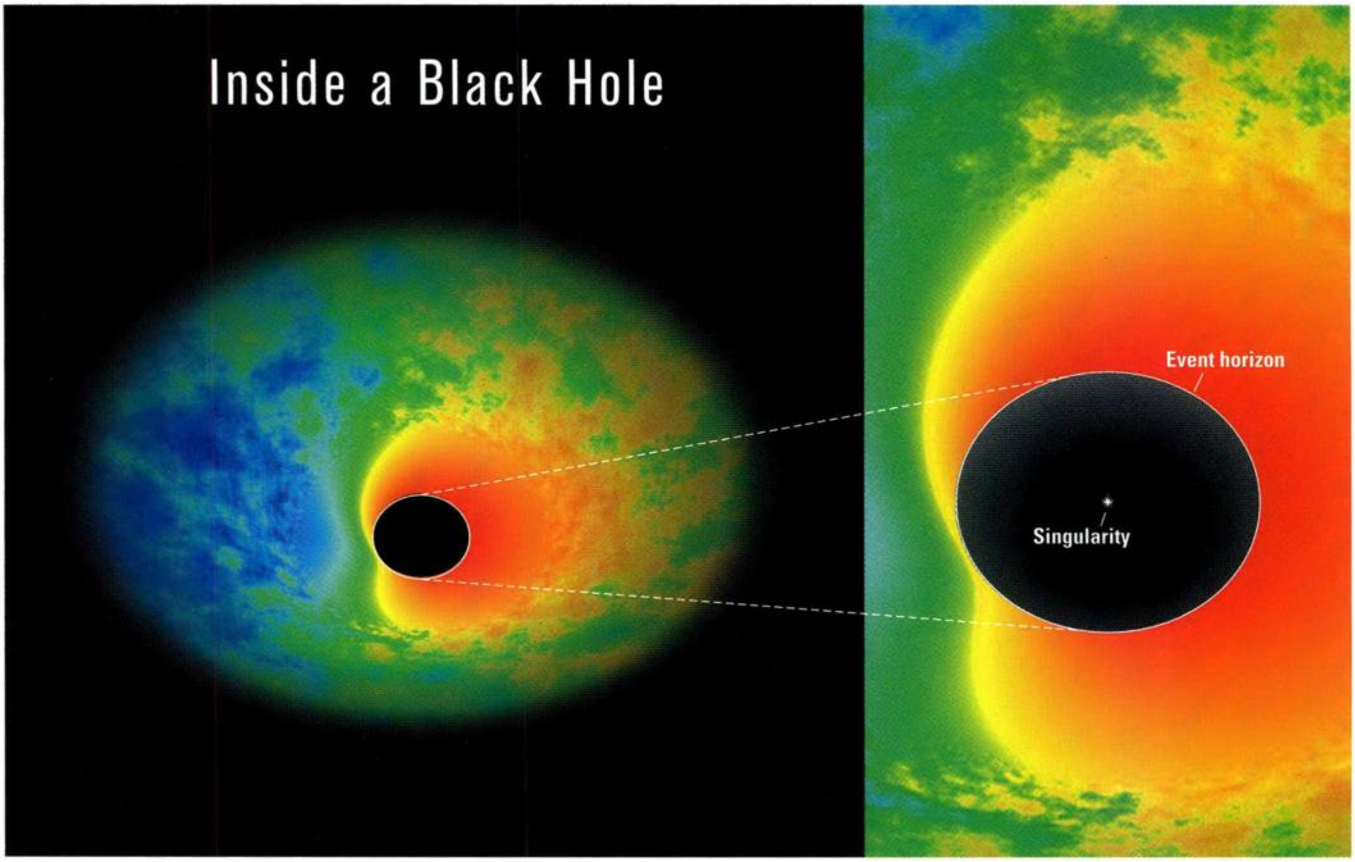
Black holes are not vacuum cleaners
in space, they won't swallow
Earth, and besides,
they're not really holes

by Neil F. Comins

Of all the exotic objects in the universe, none generate more excitement, awe, fear, and misunderstanding than black holes. Ask friends to free associate about black holes and I bet you'll hear things like, "black holes are like giant vacuum cleaners in space," or "black holes suck everything in." The reality is quite different and much less menacing than commonly believed.

Objects so dense that their gravitational attraction prevents matter and light from escaping them were first proposed in 1783 by the Englishman John Michell and again in 1795 by the Frenchman Pierre-Simon Laplace, as logical extrapolations of Newton's laws of universal gravitation and corpuscular light. The Michell/Laplace "dark bodies" became footnotes in the history of science when Einstein showed that Newton's law of gravitation was incorrect in the realm where matter becomes very dense and that his corpuscular theory of light was also flawed.

The Circinus Galaxy is a nearby active object that harbors a powerful black hole in its nucleus. Andrew S. Wilson/STScI



Swirling gases (seen in cool colors as they move toward an observer and warm colors as they fly away) comprise the accretion disk surrounding a black hole. The "edge" of the hole is called the event horizon: inside is the infinitely dense singularity.

Background image: Benjamin C. Bromley/ Harvard-Smithsonian Center for Astrophysics; all illustrations are by *Astronomy*: Elisabeth Rowan

Where Did Black Holes Come From?

In their present incarnation, black holes were proposed in 1939 by J. Robert Oppenheimer and his collaborators based on the equations of Einstein's General Theory of Relativity. These equations say that if matter becomes sufficiently concentrated, its gravitational attraction can overwhelm all other effects, creating regions from which matter and light can't escape. The name black hole was first applied to these light-trapping regions by Princeton astrophysicist John Wheeler in 1967.

The boundary between a black hole and the rest of the universe is called the hole's event horizon. However, no matter exists there. It is just a hypothetical shell at a distance from the black hole's center determined by its mass. Anything crossing the event horizon can never return to the outside universe. If the matter that formed the black hole was not rotating, the hole's mass would be concentrated at its center. In the far more likely event that the matter was rotating initially, its mass would form a ring inside its event horizon.

But do they really exist? We can't see black holes directly because light can't escape from them, but we can see their effects on surrounding matter, such as nearby gas and stars. Black holes have signature effects on other matter that are not duplicated by any other objects. Aided by images taken with Hubble and other powerful telescopes, astronomers over the past two decades have located an ever-growing number of black holes. Some are the collapsed cores of stars that began life with more than 8 solar masses and exploded, while the rest are much more massive and were probably created shortly after the Big Bang from vast collapsing clumps of gas around which galaxies coalesced. Such is the confidence in the observations of black holes that at the January 1997 American Astronomical Society meeting in Toronto, Canada, several astronomers predicted the existence of these so-called supermassive black holes in the centers of most of the billions of galaxies throughout the universe.

The recently discovered supermassive black holes at the centers of galaxies contain between a few million and a few billion times as much mass as the sun, making them by far the most massive individual objects in the known universe. In contrast, the stellar-core black holes range in mass between about 3 and 50 solar masses. British astrophysicist Steven Hawking has proposed a third, as yet undetected, type of black hole. Called primordial or "mini" black holes, these are believed to have formed at the beginning of time, when the Big Bang that created the universe supercompressed tiny amounts of matter. Tiny is relative, of course; the masses compressed into primordial black holes are believed to have ranged from fractions of a gram to the mass of a large planet.

Scientific understanding of black holes has exploded since the 1960s, when astrophysicists began studying them intensively. Filtered through science and science fiction writers, however, ideas about black holes still resonate false notions. Many people think that any black hole will grow so large that someday it will devour Earth. Movie and television portrayals of black holes as giant whirlpools or funnels add to the confusion. Other common misconceptions include believing that black holes are regions of empty space or "holes in space" and that they will last forever.

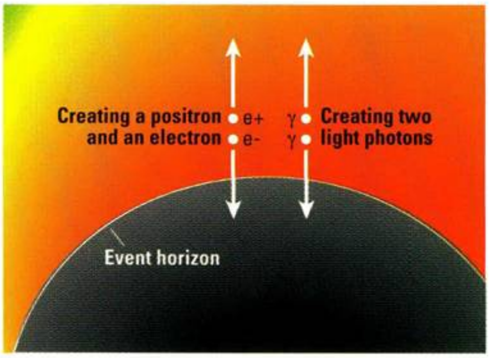
It's All in a Name

The problem of understanding black holes begins with their name. Black holes are not necessarily black nor are they holes. “Black” normally indicates the total absence of color and it is applied to black holes to mean the total absence of emitted light or other radiation. Large black holes are pretty much black. But smaller black holes can radiate energy. In 1974, Hawking proposed a mechanism by which black holes transform their mass into both radiation and particles that leave the vicinity of the hole. He asserted that small black holes thereby evaporate, glowing more brightly in the process.

The “Hawking process” of black hole evaporation works like this: All the time and throughout all space, pairs of particles are spontaneously created. They annihilate each other in such short times (typically in 10 to 23 seconds) that their presence does not violate any law of physics. Inside our bodies, for example, space is a seething foam of these “virtual” particles. We know these particles exist because they have been observed in high-energy particle accelerators: A rapidly moving real particle striking a pair of virtual particles before they annihilate each other, separates them from each other and makes them real.

Virtual particles created just outside a black hole's event horizon can also become real. If one particle in such a pair is slightly closer to the event horizon than its companion, the black hole's enormous gravitational force on the closer one will be so much greater than the force on the one farther away that the difference will rip them apart and make them real. The one closer to the hole always falls into it, but the one farther away often becomes real with enough outward speed so as to completely escape from the hole.

It may seem that a black hole should grow more massive due to the Hawking process, since it always pulls in at least one of the particles it creates. You can see that this doesn't happen by adding up the mass it gains and loses: The gravitational energy used to make the particles real comes from the mass inside the black hole. The amount of mass converted into the gravitational energy that rips the virtual particles apart is given by Einstein's mass-energy equation $E = (2m)c^2$, where 2m is the total mass of



Black holes are not necessarily black nor are they holes. Smaller black holes can radiate energy.

Virtual particles like those which produced the tracks below are created by black holes, but have very short lifetimes, quickly annihilating each other. CERN

Black holes don't last forever. The ones with the mass of a mountain should be dying just about now, some 14 billion years after the Big Bang.

the two, newly formed particles. This gravitational energy passes out through the event horizon, and creates the two particles, shrinking the black hole's mass by 2m. When only one particle falls back in, the black hole's mass increased, but only by m, half the amount by which its mass decreased moments before. The net result is that the hole loses mass equal to the mass of the particle that escapes from it completely. As seen from far away, very small black holes appear to be radiating matter and electromagnetic radiation, all of which is actually created outside the event horizon. So not all black holes are black.

As a black hole shrinks, its event horizon gets closer and closer to its center. Interestingly, the equations reveal that the evaporation rate increases as the horizon shrinks, even though the hole's mass is decreasing. Each black hole should vanish in a final, staggering burst of "Hawking radiation." Astronomers are looking for these telltale explosions. So, black holes do not last forever. The time scales for completely evaporating a black hole are instructive. The smallest primordial ones evaporate in much less than a billion years. Those with the mass of a mountain should be dying just about now, some 14 billion years after the universe began. A black hole with the mass of the sun will vanish after about 10^{62} years, while the ones at galactic centers will take millions or billions of times longer.

Are Black Holes Holes?

Next, we consider why black holes really aren't holes. Here, too, the words get in the way. My dictionary has 20 definitions of a hole; two are relevant. First, a hole is "a hollow place in a solid mass; a cavity." This is the one many people associate with black holes: a cavity or void in space. But black holes are crammed full of highly condensed matter. They are not cavities.

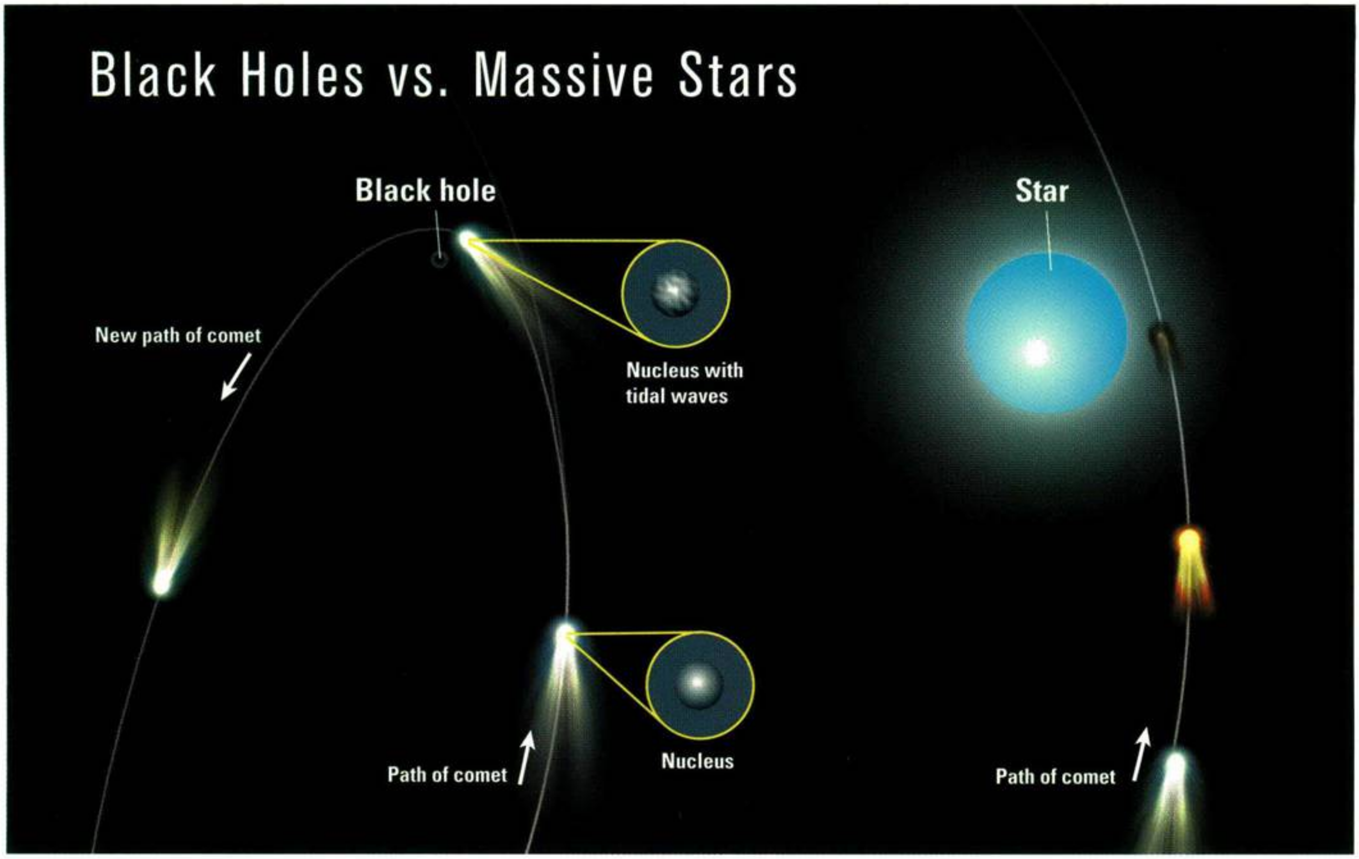
The second relevant definition is "an opening through something; a gap." While Einstein's equations are equivocal about this, there is a consensus that black holes do not connect different regions of space like the "wormholes" we see depicted in science fiction movies. Yeah, but, a black hole is a place that is outside the regular universe. It is a hole or gap in the fabric of the universe. Besides the problems with the word "hole" just mentioned, black holes are not completely "outside" the universe. They communicate with the rest of it in three ways. First, the mass in the black hole creates precisely as much gravitational attraction on distant objects as it did before becoming a black hole. Second, the black hole's angular momentum is precisely the same as it was before its matter became a black hole and, indeed, its rotation affects the space just outside its event horizon in strange ways. Third, the net electric charge of all matter in the black hole (the difference between the number of positive and negative charges) is felt outside its event horizon just as it was before the charges entered the black hole.

So black holes are not holes, either. What about the truth of other popular beliefs? By far the most common one is that black holes are cosmic vacuum cleaners. For two reasons, black holes are actually less effective in drawing objects into themselves than was their mass before it became a black hole. First, stellar core black holes are so small that they can only consume a tiny volume of matter at any time. The event horizon of a 10 solar-mass black hole is only 10 miles from its center, while a 10 solar-mass star has a 20-million-mile radius. Consequently, black holes might gravitationally attract large volumes of gas (from a companion star, say), but the black hole is so small that the gas must spiral around it, sometimes for years, like water around a drain, waiting to get pulled in.

Second, the only way black holes can absorb matter is by their gravitational attraction. A star of the same mass can also use other physical effects to absorb matter. Consider a comet flying toward a 10 solar-mass star on a trajectory that would take it within a thousand miles of the star's core, if it survived that long. The tremendous heat output of the star would evaporate the gases in the comet before impact, while the rock and metal in the comet would vaporize when it entered the star's outer layers.

Not as Good as a Hoover

Now suppose the same comet flew on the same path toward a 10 solar-mass black hole. The gravitational attraction of the hole on the comet would be the same as that from the equivalent-mass star. Because the amount of Hawking radiation from a stellar black hole is minuscule compared to the output of a star, the black hole would not vaporize the approaching comet. Furthermore, the hole is so small that the comet's closest approach would be 985 miles from the event horizon. At that distance, the hole's gravity would act as gravity from a normal object, causing the comet to change direction as it passed. The comet would swing past the black hole and depart in a new direction, without having been gobbled up or destroyed as it was by the star. At worst, the gravitational force on the comet's solid body (its nucleus) would be strong enough to tear it apart by creating tides on it like the moon creates on Earth. But the comet would



survive the passage either intact or in a few pieces. Even billion solar-mass galactic black holes only act gravitationally on the rest of the universe; astronomers see gas and stars orbiting around such bodies, without being sucked in. So black holes have no magical ability to suck in external matter and — regardless of what else happens — one is not going to grow and eventually swallow Earth.

However, black holes do show some weird effects on space very close to them. The distance from the center of the black hole to its event horizon is called the Schwarzschild radius. All the weird effects from black holes occur within about ten Schwarschild radii of the center of the hole. Beyond that rather limited distance, the only effect of the black hole on other objects is via the hole's normal gravitational attraction, just discussed.

The most bizarre misconceptions about black holes I have encountered are those created by some theologies either to intimidate young children or to explain black holes in religious contexts. While interviewing college students about their beliefs about black holes prior to taking a college astronomy course, I was astonished to learn that several of them had been threatened by their religious leaders or religiously oriented parents with being "sent into" a black hole if they misbehaved. This has the double effect of intimidating the child and associating science with evil. Other students were told that black holes are places where the souls of as-yet-unborn children reside.

While astrophysicists have accumulated an impressive body of knowledge about the true nature of black holes, we don't yet know everything there is to know about them. Most of our ignorance centers around the nature of the matter that collapses into the hole. It becomes so densely packed that none of our current physical theories are adequate to explain it.

What needs to be done — essentially one of the holy grails of modern physics — is to combine general relativity with the theory of matter called quantum mechanics, which has brought us computer chips and lasers, among other things. Called quantum gravity, physicists expect this new theory to provide deep insights not only into black holes, but also into the state of matter just after the universe formed. And who knows — it might bring knowledge we can even apply in the coming millennium. **A**

Neil F. Comins is professor of astronomy and physics at the University of Maine. He is author of What If the Moon Didn't Exist? *and coauthor of* Discovering the Universe. *Comins collects misconceptions about astronomy. You can share misconceptions that you have encountered with him at galaxy@maine.maine.edu.*

Think a black hole is fiercer than the typical massive star? Think again. A comet orbiting around a 10 solar-mass black hole (left) would clear and live on, despite the black hole's great mass. The star, however, would radiate the comet, warming it up and drawing it into its huge sphere, destroying it.

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SkyQuest XT8
The XT8's prodigious performance on both solar system and deep-sky denizens have made it the telescope of choice for thousands of astronomers, from beginners to die-hard hobbyists.

Steel tube, 200mm parabolic mirror (f.l. 1200mm, f/6), 1.25" aluminum R&P focuser, 6x30 achromatic finder scope, 25mm (48x) and 9mm (133x) Plössl eyepieces (1.25"), Moon filter, eyepiece rack, 5" flanged altitude hubs, CorrecTension Friction Optimization, dust cap. Weight: tube 19 lbs., base 23 lbs.

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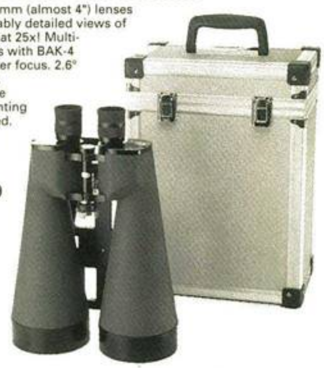

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sky Show

april

Spring into observing with bright planets and the return of a periodic comet.

by Martin Ratcliffe and Alister Ling

The moon slides near the Beehive Cluster in this image, as it will this month. Terence Dickinson

Earth and sky come alive at this time of year. There's no better time for sidewalk astronomers to lure in the public than when the mild evening air is full of fragrances and Jupiter and Saturn are ready to entrap the imagination of passers-by.

The brilliant stars of winter still adorn the spring sky like glittering jewels, surely an invitation to begin a lifelong passion. Point out that the supergiant stars of the Orion spiral arm display a wide range of colors from the orange glows of red giants Betelgeuse and Aldebaran to the pale aquamarine blues of Rigel. Don't forget to treat newcomers to low-power views of the splashy Beehive and Pleiades star clusters. By mid-month, Venus returns as a blazing morning "star." Even a small spotting scope will show you its phase as it rapidly changes from a thin crescent to a half-moon. Take a peek once a week to see noticeable differences. The crescent Moon passes well to its right on the morning of the 19th.

While we wait for the next bright comet to come from the depths of the Oort cloud, we can practice observing periodic Comet Schaumasse (designated 24P/Schaumasse). This 10th-magnitude fuzzy snowball will resemble a typical elliptical galaxy in a backyard telescope. You can find it sliding upward against the background stars of Taurus and Auriga about an hour after sunset.

Orion's brilliant stars remain visible in the springtime evening sky. Randall Wehler

Comets leave dust trails, and when Earth sweeps up the dust, we see a meteor shower. Some 15 to 20 "shooting stars" per hour might be seen on Saturday night, April 21/22, emanating from the constellation Lyra. These April Lyrids appear when modestly swift specks of comet dust vaporize in the upper atmosphere at 30 miles per second (50 km/s). You may notice a few Lyrid meteors a few days on either side of the maximum.

It can be fun to follow asteroids as they move against a backdrop of stars, but it's a real treat to see one in front of a galaxy's spiral arms, masquerading as a supernova. This month, 6 Hebe does it twice. Other major sights also await: the grouping of Jupiter, Saturn, and the crescent moon. The evenings of April 24 through 26 should be spectacular.

As the moon moves around the sky, it sometimes covers up, or occults, bright or unusual background objects. On the night of April 2/3, the Beehive Cluster (M44) in Cancer succumbs to the moon's dark side. The cluster's stars will begin winking out after 1:30 A.M. EDT on the east coast, after 11 P.M. MDT for central observers, and after 10 P.M. PDT on the west coast.

All too soon, the planetary blossoms of Jupiter and Saturn will fade into the evening twilight late in May, so enjoy them while you can. Despite Earth's turbulent atmosphere, a view of Saturn with its rings wide open will fire the imagination of any newcomer.

2001 April

1 First quarter moon is at 6:49 A.M. EDT

5 The moon is at perigee (226,682 miles from Earth), 6:05 A.M. EDT

6 Mercury passes 10° south of Venus, 5 P.M. EDT

7 Asteroid Amphitrite is at opposition, 10 P.M. EDT
Full moon is at 11:22 P.M. EDT

12 The moon passes 1.3° north of Mars, 10 P.M. EDT

14 The moon passes 0.9° north of Ceres, midnight EDT

15 Last quarter moon is at 11:31 A.M. EDT

16 Jupiter passes 5° north of Aldebaran, 10 A.M. EDT
The moon passes 3° south of Neptune, noon EDT

17 The moon is at apogee (251,348 miles from Earth), 2:06 A.M. EDT
Venus is stationary, 1 P.M. EDT
The moon passes 3° south of Uranus, 7 P.M. EDT

20 The moon passes 10° south of Venus, 4 P.M. EDT

21 Asteroid Herculina is at opposition, 2 P.M. EDT (page 65)

22 Lyrid meteor shower peaks (page 64)

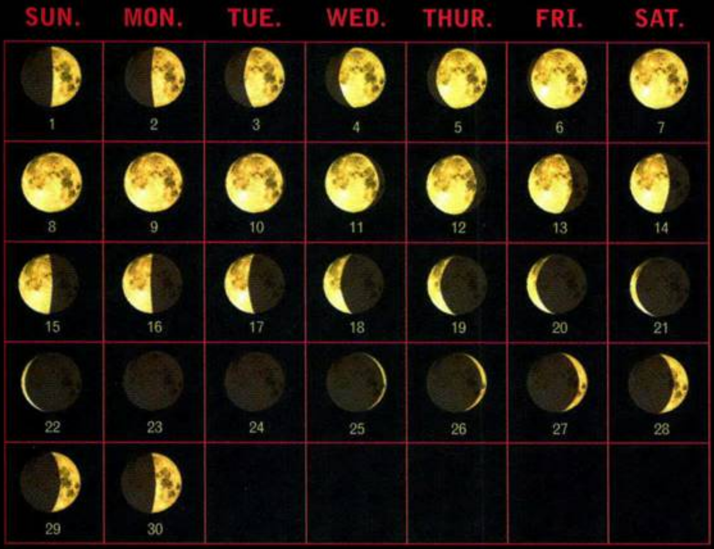
23 Mercury is in superior conjunction, 5 A.M. EDT
New moon is at 11:26 A.M. EDT

25 The moon passes 1.4° south of Saturn, noon EDT (page 63)

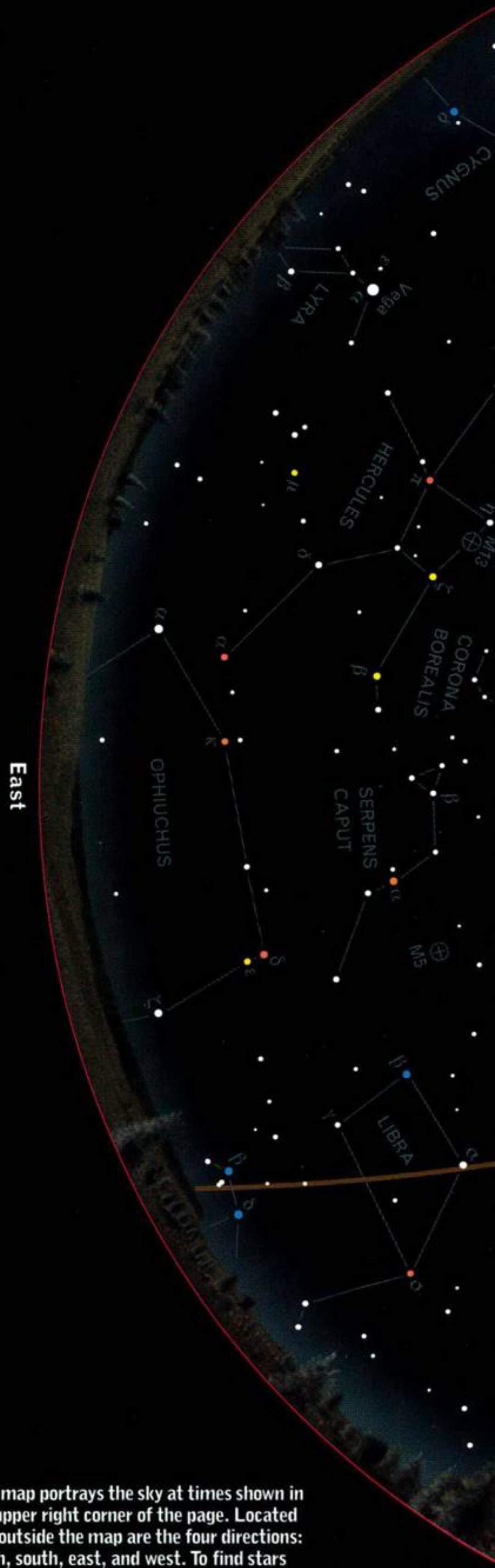
26 The moon passes 1.8° south of Jupiter, 9 A.M. EDT

29 Asteroid Juno is in conjunction with the sun, 10 P.M. EDT

30 First quarter moon is at 1:08 P.M. EDT

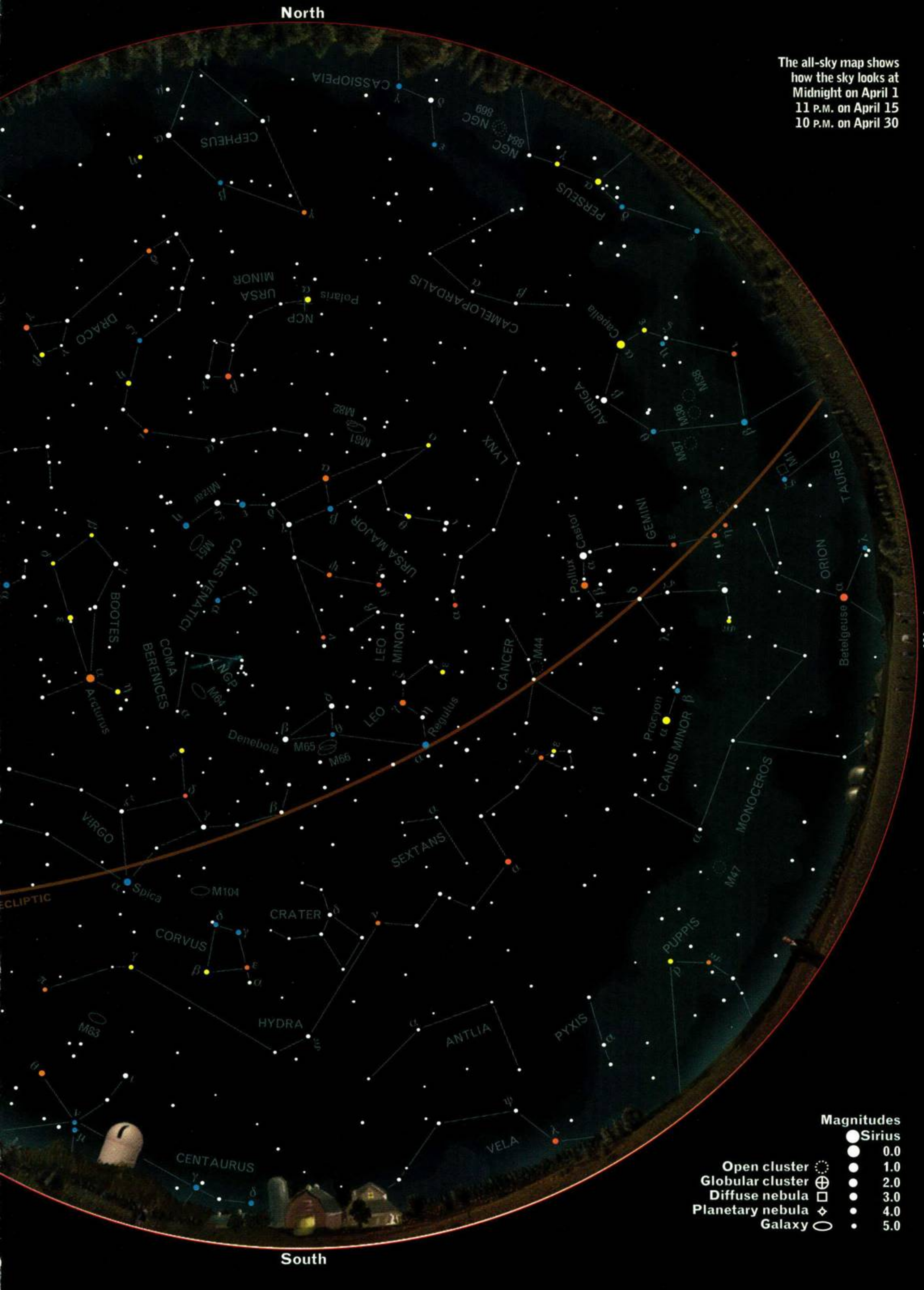


SUN.	MON.	TUE.	WED.	THUR.	FRI.	SAT.
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					



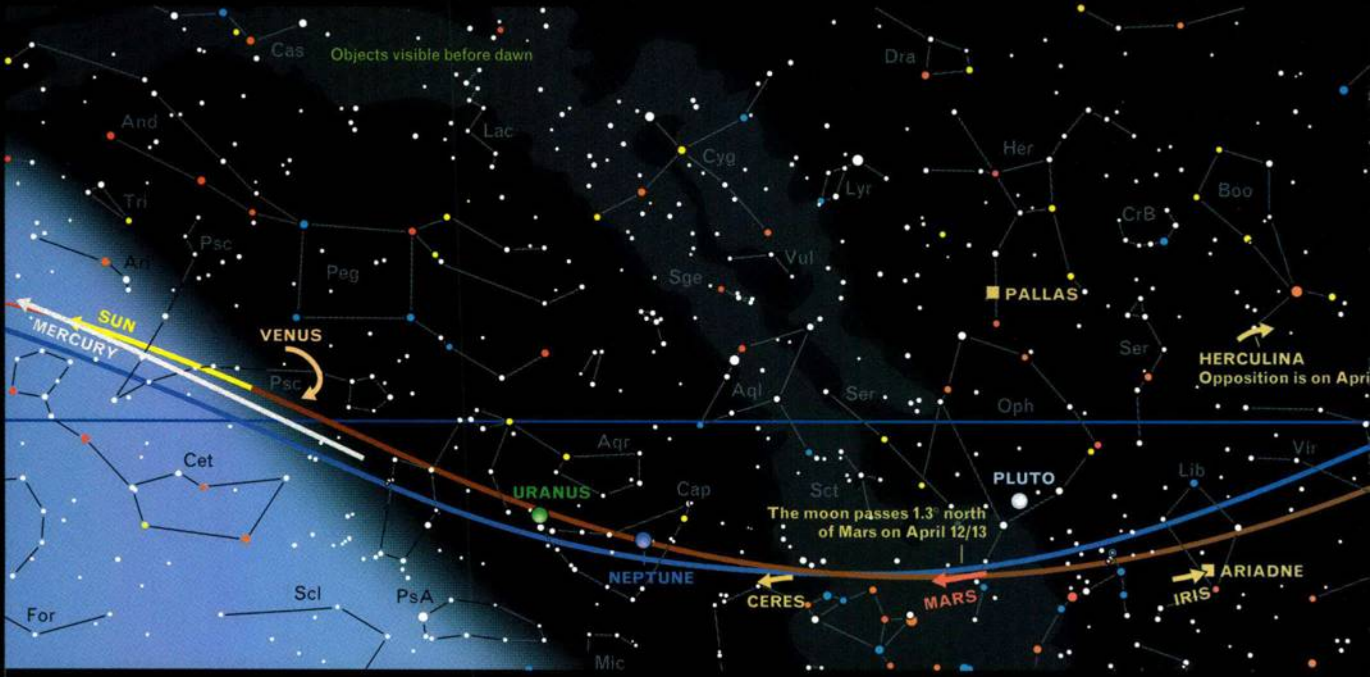
This map portrays the sky at times shown in the upper right corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

The all-sky map shows
how the sky looks at
Midnight on April 1
11 P.M. on April 15
10 P.M. on April 30


North
South
West
CASSIOPEIA
CEPHEUS
NGC 869
NGC 884
PERSEUS
URSA MINOR
Polaris
NCP
DRACO
CAMELOPARDALIS
Capella
AURIGA
M36
M37
M38
M81
M82
LYNX
M1
TAURUS
M35
Mizar
URSA MAJOR
GEMINI
Castor
Pollux
ORION
Betelgeuse
M51
CANES VENATICI
BOOTES
LEO MINOR
COMA BERENICES
NGP
M64
CANCER
M44
Arcturus
LEO
Regulus
Denebola
M65
M66
Procyon
CANIS MINOR
MONOCEROS
VIRGO
ECLIPTIC
Spica
M104
SEXTANS
M47
CRATER
CORVUS
PUPPIS
HYDRA
M83
ANTLIA
PYXIS
VELA
CENTAURUS
Magnitudes
Sirius
0.0
1.0
2.0
3.0
4.0
5.0
Open cluster
Globular cluster
Diffuse nebula
Planetary nebula
Galaxy

Path of the Planets

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system object


Cas
Objects visible before dawn
Dra
And
Lac
Her
Cyg
Lyr
Boo
Tri
CrB
Psc
Vul
Ari
Peg
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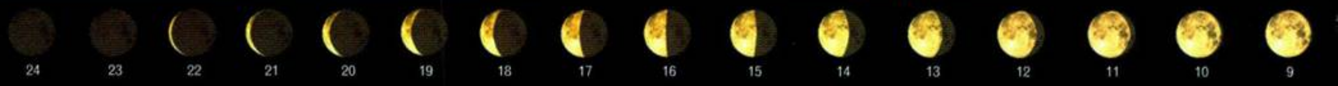
PALLAS
SUN
MERCURY
VENUS
Ser
HERCULINA
Opposition is on Apri
Psc
Aql
Ser
Oph
Vir
Cet
Aqr
Lib
URANUS
Cap
Sct
PLUTO
The moon passes 1.3° north of Mars on April 12/13
NEPTUNE
ARIADNE
CERES
MARS
IRIS
Scl
PsA
For
Mic


24
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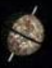
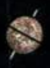
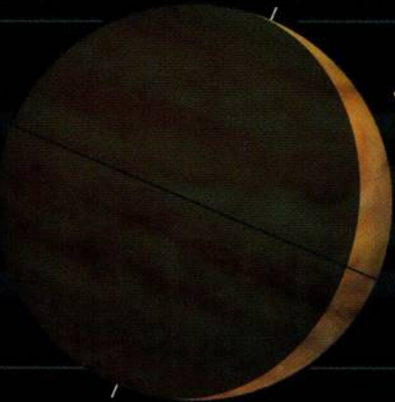
11
10
9

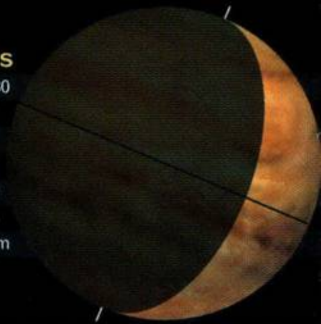
To locate the moon in the sky, draw a line from the phase s

PLANETS	MERCURY	MERCURY	VENUS	VENUS
Date	April 1	April 15	April 15	April 30
Magnitude	−0.3	−1.2	−4.4	−4.5
Angular Size	5.6"	5.1"	52.4"	41.5"
Illumination	80%	95%	8%	22%
Distance (AU) from Earth	1.204	1.321	0.319	0.402
Distance (AU) from Sun	0.438	0.367	0.723	0.725
Right Ascension (2000.0)	23h31.1m	1h01.8m	23h59.1m	0h08.8m
Declination (2000.0)	−5°44'	4°48'	5°30'	2°59'



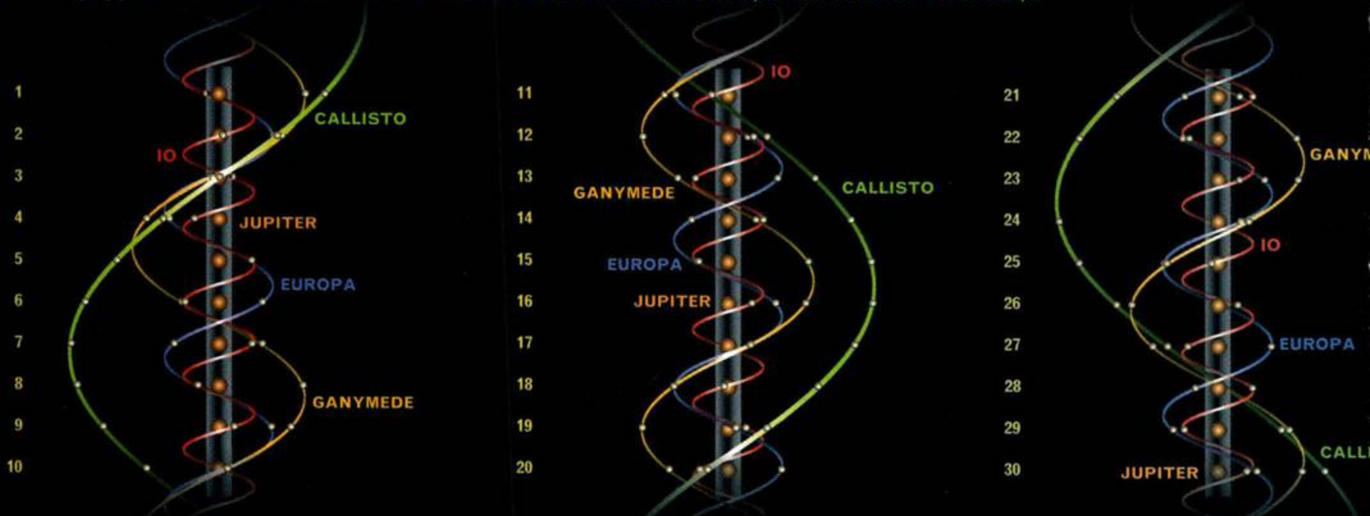




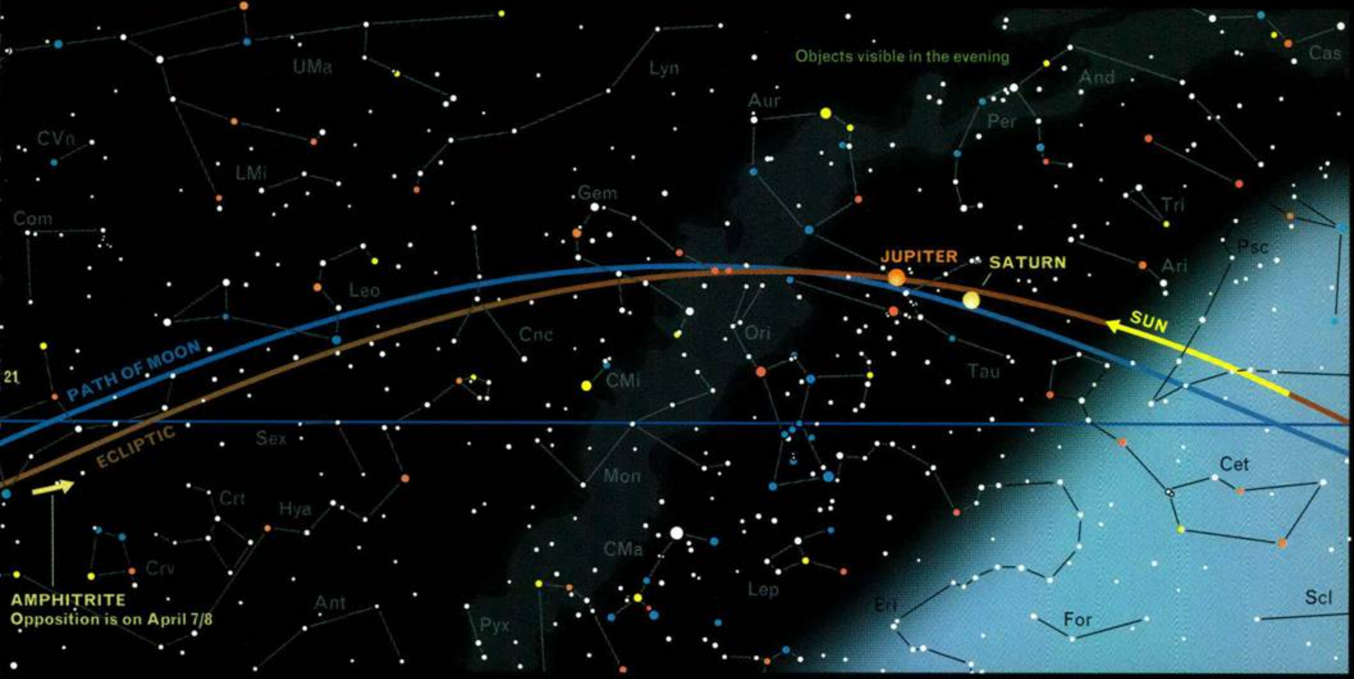


Jupiter's Moons

Dots display positions of Galilean satellites at 11 P.M. EDT on date shown. South is at top to match the view in a telescope.



s during the month.


UMa
CVn
LMi
Com
Lyn
Aur
Objects visible in the evening
And
Cas
Per
Tri
Gem
Leo
JUPITER
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Ari
Psc
SUN
Cnc
Ori
Tau
PATH OF MOON
21
CMi
ECLIPTIC
Sex
Cet
Mon
Crt
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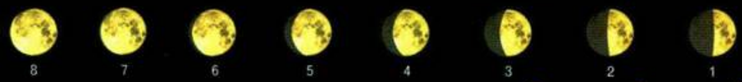
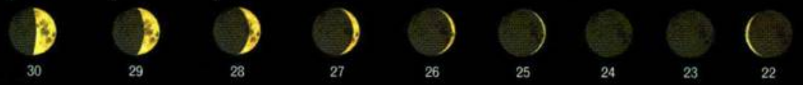
Crv
Lep
Ant
Pyx
Eri
For
Scl

AMPHITRITE
Opposition is on April 7/8



hown for the day straight up to the curved light-blue line.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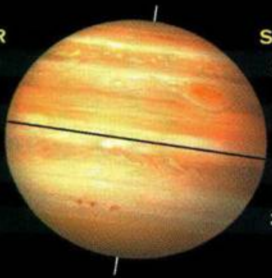
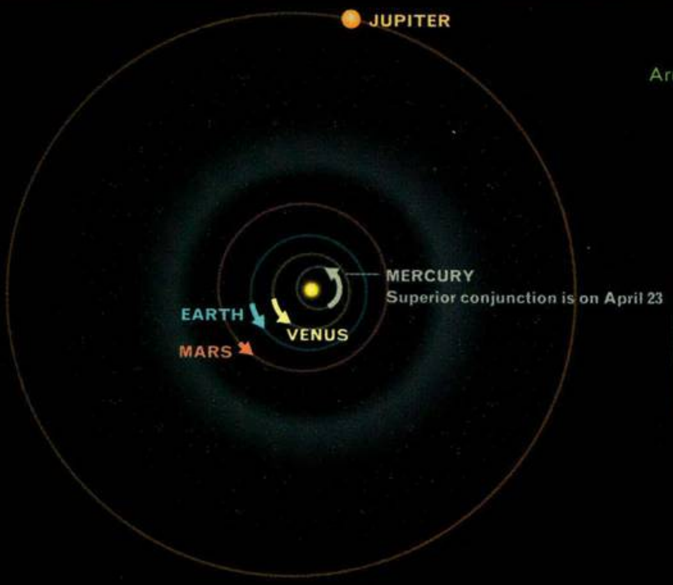


MARS	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
April 1	April 30	April 15	April 15	April 15	April 15	April 15
−0.2	−1.0	−2.0	0.2	5.9	7.9	13.8
10.4"	14.1"	34.4"	16.8"	3.4"	2.3"	0.1"
90%	93%	100%	100%	100%	100%	100%
0.903	0.662	5.736	9.908	20.433	30.323	29.727
1.565	1.529	5.079	9.097	19.967	30.104	30.371
7h19.4m	17h52.3m	4h34.6m	3h50.0m	21h46.3m	20h43.9m	16h59.9m
−22°48'	−24°06'	21°33'	18°16'	−14°10'	−17°58'	−11°59'

EDE

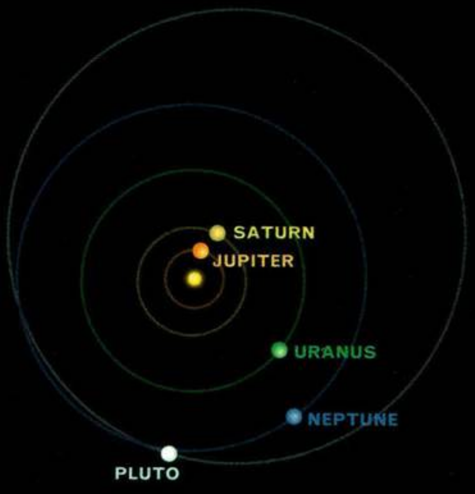
STO


JUPITER
MERCURY
EARTH
VENUS
MARS

MERCURY Superior conjunction is on April 23

The Planets in Their Orbits

Arrows and dots show planets' positions during the month.


SATURN
JUPITER
URANUS
NEPTUNE
PLUTO

The Majestic Spiral Galaxy M100

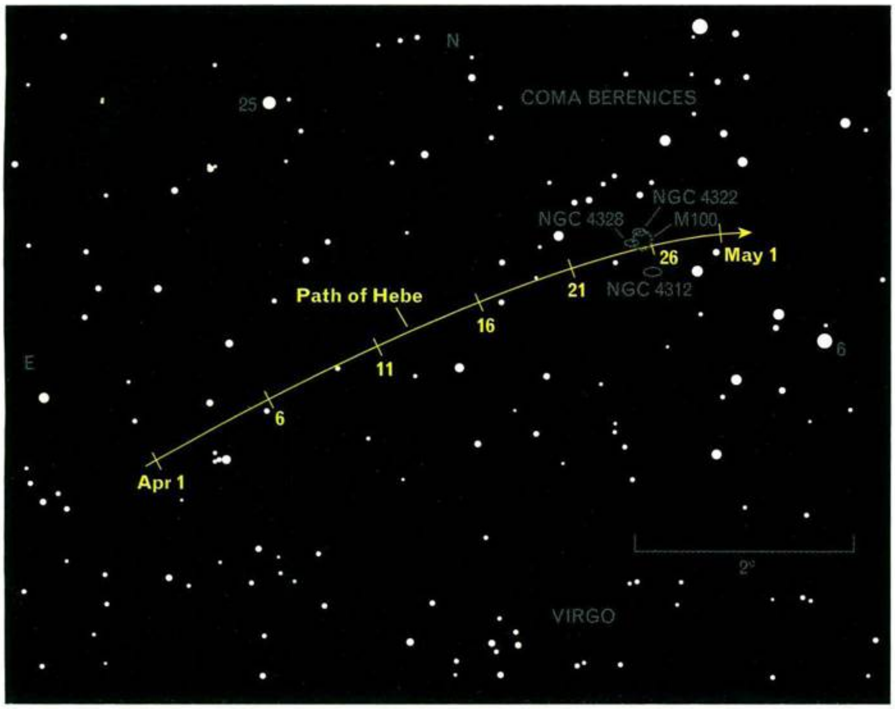
Imagine your senses tingling as you climb the ladder, and feel them reel when you peer wide-eyed at the grand spiral galaxy floating in front of you. For a second you're way out there, but the sounds of your own voice startle you back to reality. But what a reality. You are on blue spaceship Earth on a voyage around your own spiral galaxy, every bit as beautiful as the one before you. Hope you have some time on your hands: the universe contains at least 125 billion galaxies; some 10,000 or more are visible in backyard telescopes.

Back in the late 1700s, when the galaxy M100 (NGC 4321) in Coma Berenices was discovered, astronomers had a tough time imagining a universe that was much bigger than the solar system. As they star-hopped with their 3- to 6-inch refractors to reach 6 Comae Berenices, they hadn't the slightest clue that a 9th-magnitude soft patch of light just 2° to the east was, in reality, a marvel to blow the mind.

Today's 4-inch scopes show more than a pale glow. Boost the power up to 150x under a dark sky to reveal a disk that is unevenly brighter into the core. The mottling comes from the spiral structure first seen by William Parsons, Third Earl of Rosse, through his 72-inch Leviathan telescope in Ireland. Today's 12-inch scopes and a steady transparent night can now reveal the details. Let your eye get used to the darkness produced by magnifications past 300x. The subtleties stand out more, despite their faintness. The Hubble Space Telescope reveals that these spiral arms are loaded with large gas clouds much like our own Eagle, Lagoon, and Orion nebulae.

Bright spiral M100 is one of the most recognizable galaxies in the Virgo cluster. Jack Newton

When you use higher magnifications, smaller objects are easier to see. If you've got a 6-inch scope, try for NGC 4312, a 12th-magnitude elongated galaxy just south of M100. A decent challenge for a 10-inch scope would be the companion galaxies NGC 4328 and NGC 4322, glowing feebly at 14th-magnitude. In this neck of the celestial woods, large scope owners will find that there's no end to faint smudge galaxies receding into the depths of infinity. You may want to set aside several clear evenings this month and simply scan starfields in the vicinity of Virgo and Coma Berenices. You'll undoubtedly strike across a multitude of fuzzy galaxies; stumbling onto something in the eyepiece and then identifying it on a good star atlas makes for great fun. Try to find a variety of galactic forms; can you see the nuclei or spiral arms of any specimens?



Make sure you observe M100 on the nights of the 25th and 26th, when asteroid 6 Hebe lies positioned near the southern flank of the grand spiral, just 6' from its core; M100 itself is about 6' across. Almost due south you can find a magnitude 9.7 star about 10' away.

When a supernova explodes in a galaxy, a single star can briefly outshine billions of others. But the vast distance to M100 of 40 million light-years would dim the mind-boggling output of such a cataclysmic explosion. A supernova in M100 would be similar in brightness to 6 Hebe's weak solar reflection of magnitude 10.3.

The automatic and visual supernova search patrols currently underway will not send out an alarm for 6 Hebe as it crosses the galaxy, because its motion will betray it as an asteroid.

The giant planets Jupiter and Saturn set in the west, while the red planet **Mars** rises in late evening and improves dramatically this month. Use these April evenings after sunset as your last chance for a good clear look at **Jupiter** and **Saturn**. Saturn sets by 11 P.M. on April 1 and Jupiter follows about one hour later. As sunset slips later each day and the two planets set earlier, the observing window for the two planets diminishes rapidly. By April 30, Jupiter sets just over two hours later than the sun and floats only 20° high as the sky darkens. This low altitude makes clear viewing of details on the planet quite difficult due to turbulence in our atmosphere, so make the most of these next few weeks.

Saturn shines at magnitude 0.2 and remains south of the Pleiades Cluster (M45) in Taurus the Bull. It's closest to the cluster on April 21, some 5.8° away (though Saturn's position changes pretty slowly). The planet's rings are tilted to reveal their southern face, and the southern hemisphere of Saturn's globe is in full view. Look for bright spots on Saturn's generally plain-faced planetary disk. You're going to need a 6-inch scope and at least 150x magnification to pick up such details, although smaller scopes will offer plenty of wonderful views of the planet and its brighter moons.

Jupiter continues its brilliant showing in the western sky after sunset. It stands 5° north of Aldebaran in the constellation Taurus on April 12. Compare the brightness of the pair: Jupiter glows at magnitude –2.0 while Aldebaran shines at the dimmer magnitude 0.9. In addition, their color contrast startles. Jupiter reflects sunlight, and its yellowish hue indicates the high reflectivity of its cloud deck. Aldebaran, a red giant star, emits its own light and glows orange due to the temperature of its surface. Take a last look for Jupiter's Great Red Spot. The limited visibility of Jupiter makes this more of a challenge than usual, but the month starts out well with a central transit of the GRS during the evening of April 1. With the under-ten hour rotation period of Jupiter, the feature will be on view frequently during the rest of the month, and visible through small telescopes.

The spotlight shifts to Jupiter's moons on the night of April 3. An

Venus paired with the Pleiades on April 3, 1988 (right). George R. Viscome

Saturn's majestic rings (below) will approach the Pleiades this month. David Hanon

unusual transit of two shadows of the Galilean moons will occur at the same time. The shadows of Europa and Ganymede are visible as black dots on Jupiter's cloud tops between 8:49 P.M. and 9:03 P.M. CST. Times of other transit events visible this month are shown in the table on page 82.

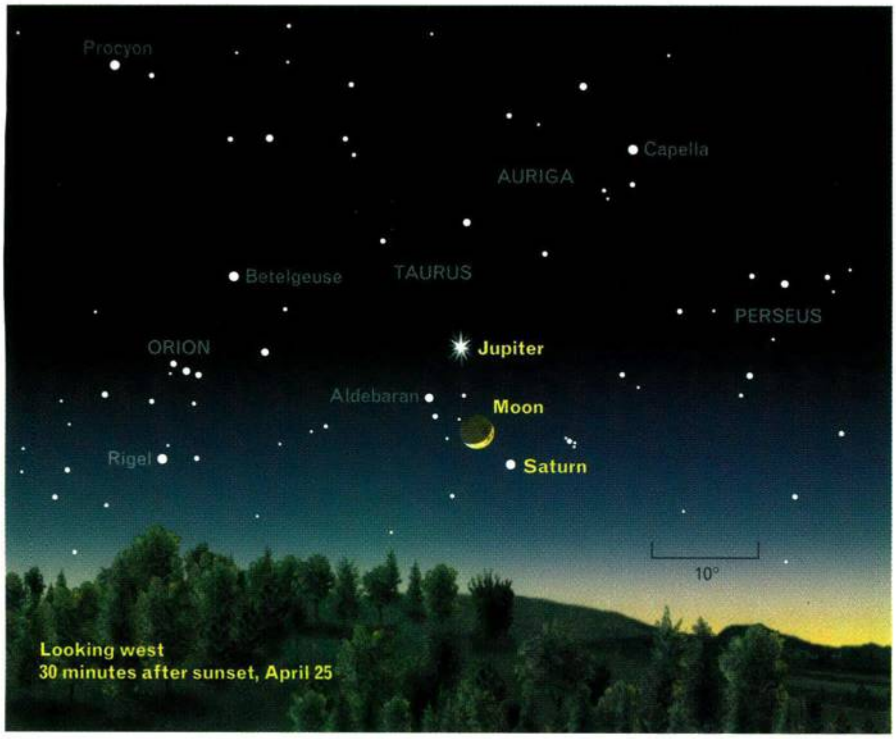
A spectacular trio illuminates the evenings of April 24 to 26. A slim crescent one-day old moon might be glimpsed low in the west after sunset on April 24, 9° below Saturn. The next night, on April 25, the waxing crescent lies less than 5° east of Saturn, forming a nice triangle with Jupiter, 7° higher than the moon. On April 26, the moon has slipped past Jupiter and lies 6° east of the giant planet.

During the next four months Mars creates a superb sight, dominating the night sky and attracting observers all over the world. Mars appears tiny through telescopes and is no match for Jupiter or Saturn, but this year's apparition is one of the best in a decade. The Red Planet rises in the east two hours after Jupiter sets in the west. Mars lies in the constellation Ophiuchus the Serpent Bearer, and moves into Sagittarius the Archer on April 19. Don't confuse Mars with Antares, its traditional rival in Scorpius, which lies more than 12° farther west. Mars is now much brighter than Antares, shining at magnitude –0.5 in early April and brightening nightly.

Mars is now within two months of opposition and reaches an apparent size greater than at any time in the past ten years. By the end of April, Mars spans 15"; it will grow 5" more by its June opposition. Details on the planet's surface will become easier to see as its apparent size grows. Refracting telescopes are the best for planetary viewing because they give the highest contrast at high powers, but a variety of different types of telescopes will provide satisfactory views of the Red Planet.

If this is your first view of Mars, don't be disappointed, because an untrained eye will only see a bright orange globe with a white spot or two. Over a period of nights using high magnification of about 250 times, details will begin to pop out at you and soon you'll wonder how anyone can miss the subtle light and dark patches. Exploring Mars presents a fascinating challenge, especially during the warmer nights of early spring.

Mars revealed a relatively plain face when imaged on November 11, 2000. Don Parker



Looking west
30 minutes after sunset, April 25

As you become skilled in identifying martian features, try some color filters to highlight them. For instance, a red filter will maximize contrast of surface features, while a blue filter will brighten wispy clouds and limb hazes prevalent in the martian atmosphere. For more details about observing Mars, contact the Association of Lunar and Planetary Observers at www.lpl.arizona.edu/alpo/index.html, or write the ALPO Membership Secretary, P.O. Box 171302, Memphis, TN 38187-1302.

Venus appears in the morning sky and moves rapidly away from the sun, rising earlier each morning before dawn. It passes 8° above the sun on March 30 at its inferior conjunction. Each day its percentage of illumination increases, starting at a very slim 1-percent lit crescent on April 1 to a 10-percent illuminated disk on April 17.

Already, by this stage, Venus has reached magnitude –4.4, though it hangs in a bright, predawn sky. During the same period, the size of the venusian disk shrinks from 59" to 50" as the planet speeds away from Earth. A further 12-percent increase in illumination, reaching 22 percent, occurs by April 30, with a corresponding shrinking of its apparent size to 40". Catch it as soon as possible for the best view.

Mercury may be spotted briefly above the eastern horizon before dawn during the first few days of April. It sinks quickly into the dawn glow, but lies at almost the same altitude above the eastern horizon as Venus on April 1, but farther south. Venus is a challenge to spot in the bright sky – you'll need a clear eastern horizon. It's a brilliant "star" at magnitude –4.0, while Mercury is dimmer at magnitude –0.3.

sky Show

Meteors and Moons

Lyrid Meteor Shower

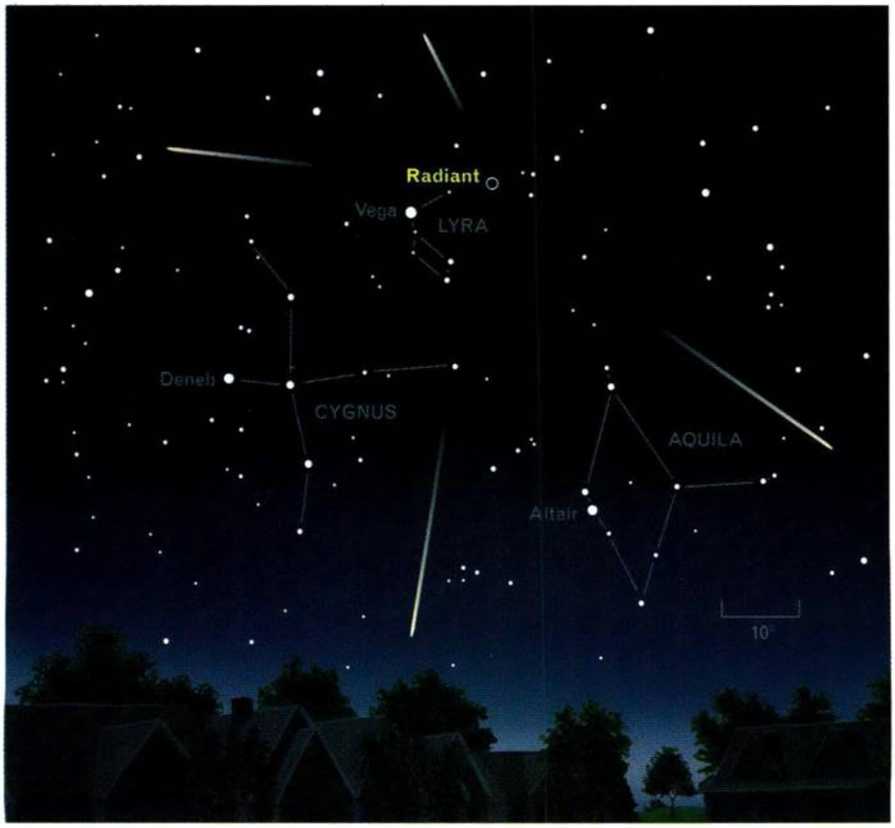
The April Lyrid meteor shower is one of the reliable showers of the year and it reaches a peak on the night of April 21/22. This year's shower is ideally timed around the dark of the moon, giving nice dark skies for observing the fainter members of this group. The radiant lies in the constellation Lyra the Harp and is well-placed for the northern hemisphere after 10:30 P.M. local time. Hourly meteor rates are variable for the Lyrids, with the 1982 shower producing as many as 90 per hour and last year's shower at 20 per hour. This year's activity should peak at about 15 to 20 per hour for an 8- to 12-hour period. Be on the lookout for the swift bright meteors that are associated with the Lyrids.

Focus on Posidonius

The lunar-walled plain Posidonius, named after a Greek philosopher, stands on the northeastern edge of Mare Serenitatis. This region comes into view as the moon reaches five days old, which occurs on March 29 and again on April 28. If the timing is just right you will catch rays of sunlight rising over its ancient walls. The crater spans 62 miles and features a network of rilles crossing its floor. A smaller crater, Posidonius A, exists near the central mountain peak. Posidonius is a spectacular crater worthy of close scrutiny. It appears to be partly filled with lava that has breached the rim in one location. Terracing gives the impression of a concentric crater.

Jovian Satellite Play

Times are CDT, and are accurate to within one minute. Io = I, Europa = II, Ganymede = III. No Callisto events occur. Oc = occultation; Ec = eclipse; Sh = shadow; Tr = transit; D = disappearance; R = reappearance; I = ingress; E = Egress. For some events the sun will still be in the sky for western U.S. observers, but will have set for east coast (U.S.) observers. In addition, Jupiter will set earlier for east coast observers, but later events are visible by west coast observers.



Jovian Moon Events

Apr. 1	7:45	I.Tr.I.
	8:52	I.Sh.I.
Apr. 2	4:33	II.Oc.D.
	5:1	I.Oc.D.
	8:18	I.Ec.R.
Apr. 3	2:15	I.Tr.I.
	3:21	I.Sh.I.
	4:28	I.Tr.E.
	5:34	I.Sh.E.
Apr. 4	1:25	II.Sh.I.
	1:49	III.Tr.E.
	1:56	II.Tr.E.
	2:47	I.Ec.R.
	3:49	III.Sh.I.
	4:3	II.Sh.E.
	6:9	III.Sh.E.
Apr. 9	7:1	I.Oc.D.
	7:21	II.Oc.D.
Apr. 10	4:16	I.Tr.I.
	5:17	I.Sh.I.
	6:28	I.Tr.E.
Apr. 11	1:31	I.Oc.D.
	2:2	II.Tr.I.
	3:45	III.Tr.I.
	4:0	II.Sh.I.
	4:41	II.Tr.E.
	4:42	I.Ec.R.
	6:10	III.Tr.E.
	6:39	II.Sh.E.
Apr. 12	1:58	I.Sh.E.
Apr. 13	1:28	II.Ec.R.
Apr. 17	6:17	I.Tr.I.
	7:13	I.Sh.I.
Apr. 18	3:31	I.Oc.D.
	4:48	II.Tr.I.
	6:36	II.Sh.I.
	6:37	I.Ec.R.
	7:27	II.Tr.E.
Apr. 19	1:41	I.Sh.I.
	3:0	I.Tr.E.
	3:54	I.Sh.E.
Apr. 20	1:6	I.Ec.R.
	4:6	II.Ec.R.
Apr. 22	1:45	III.Ec.D.
	4:9	III.Ec.R.
Apr. 25	5:31	I.Oc.D.
	7:35	II.Tr.I.
Apr. 26	2:48	I.Tr.I.
	3:37	I.Sh.I.
	5:1	I.Tr.E.
	5:50	I.Sh.E.
Apr. 27	2:26	II.Oc.D.
	3:1	I.Ec.R.
	6:45	II.Ec.R.
Apr. 29	1:8	II.Sh.E.
	2:39	III.Oc.D.
	5:8	III.Oc.R.
	5:45	III.Ec.D.

Comet 24P/Schaumasse Returns

Every month we hope to hear of a new comet that will blaze across Earth's skies. Most new comets remain very faint. Fortunately, we can count on known periodic comets to whet our appetite while we wait for the next really big one.

Returning to the inner solar system every 8.2 years, Comet 24P/Schaumasse never gets closer to the sun than 20 million miles (36 million km) outside of Earth's orbit. Because it is much smaller than Comet Halley, for example, it is not expected to brighten to visibility except for telescopes and larger binoculars. Comet Schaumasse should mimic an ordinary Coma/Virgo galaxy of about 10th magnitude.

To get a good look, you'll need to take your scope out into country skies after the 10th, when the bright moon no longer hangs in the evening sky. You'll find Schaumasse tucked between Auriga and Jupiter. On the 18th and 19th, it lies a bit more than 1° (two apparent moon widths) north of Beta (β) Tauri.

At about magnitude 10, Comet Schaumasse should be readily visible at low power in almost any scope. Once you find it, increase the magnification to look for a faint tail as well as structure in the inner coma. If you see a pinpoint core, you'll have seen the so-called false nucleus. Veils of bright dust, lit up by sunlight, obscure a cometary nucleus's surface.

Asteroid 6 Hebe Visits Galaxy Country

Spring offers one of the best times for asteroid hunting. Far from the crowded Milky Way, solar system rocks are easier to find among the fewer and fainter stars. As a bonus, observers get the opportunity to spot galaxies along the way.

Discovered early on in the search for the so-called "missing planet" between Mars and Jupiter, 6 Hebe turns out to be a moderately big asteroid, about 120 miles (190 km) across. If you're anxious to spot the asteroid early in the month, try looking on the 8th, when it skims a mere 3' from the bright barred spiral NGC 4548, the galaxy most likely to be the missing "Messier 91."

Hebe will pass in front of the face-on spiral NGC 4421 on the evening of April 19. On Sunday evening, April 22, observe it pulling away from NGC 4379, a 12th-magnitude galaxy. Finally, on the night of the 25/26, Hebe slides 1° south of the magnificent spiral M100, the focus of some important Hubble distance scale measurements.

High-Numbered Rock Passes Tight Double Star

Asteroid 532 Herculina is having a great opposition, shining at 9th magnitude, because Earth is about as close to it as possible. By mid-month it's fairly easy to find, lying just 30" (one moon width) south of the double star Zeta (ζ) Bootis. A greater challenge will come from splitting the double star. You'll need a dark, steady night on which you can crank up the power past 250x in order to split the twin magnitude 4.5 components. Their 0.8"-gap usually dictates a minimum 6-inch scope, but top-notch modern optics in a 5-inch should push you past the limit. Such challenges will recharge you as an observer.

Comet P/Schaumasse last appeared prominently in 1993. Giovanni Dal Lago and Roberto Cazzola

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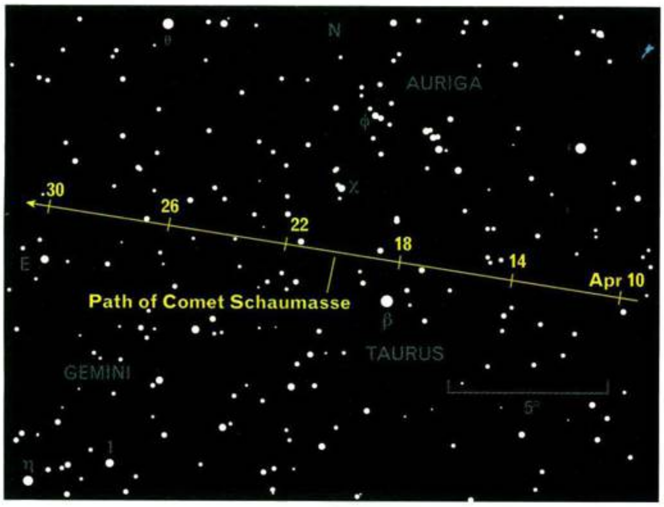
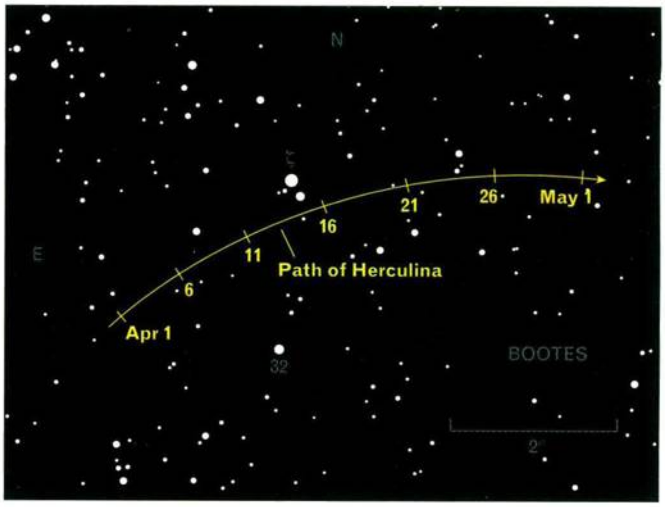
Martin Ratcliffe is Director of Theaters at the Exploration Place in Wichita, Kansas. Alister Ling is a meteorologist working for Environment Canada in Alberta.





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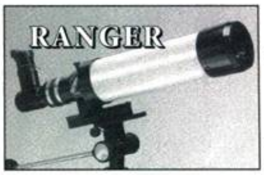

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LONE STAR

Belly up to telescopes at the Texas Star Party

SIX HUNDRED FIFTY-FIVE PEOPLE CAN RAISE A LOT OF DUST in southwest Texas, and from April 30 to May 7, 2000, that's exactly what happened. Held amidst prickly pear cacti and chollas, the Texas Star Party (TSP) is one of the most popular annual star parties in the United States. Attendees often travel from as far as Australia, Brazil, Denmark, and Canada to observe deep-sky treats, swap stories and expertise, show off equipment, and make new friends.

"This is one of the top three star parties in the nation," says Steve Goldberg, a member of the Houston Astronomical Society and the Fort Bend Astronomical Society, and one of the co-chairpersons of the TSP. Goldberg lists several reasons for the success of the TSP: its length, dark-sky location, and informative lecture series. That the TSP is geared toward observers — rather than amateur telescope makers and vendors — also contributes to its popularity.

Observers have been the focus of the TSP since its inception in August 1979, when it was held as a weekend campout in the Davis Mountains State Park. Founded by members of the Austin Astronomical Society, astronomers at the University of Texas McDonald Observatory, and Deborah Byrd, a former science writer and producer of the nationally-syndicated radio series, *Star Date*, the first TSP featured a speaker and a special observing at McDonald Observatory, as well as amateur observing sessions. By 1982, the TSP ranked behind only Stellafane and Riverside in attendance. It was also the year the TSP moved to Prude Ranch.

Established in 1898, Prude Ranch lies approximately 200 miles southeast of El Paso. Guest lodges, bunkhouses, RV hookups, and tenting areas accommodate visitors. Wide-open fields offer plenty of room for telescopes. Prude is also a working cattle ranch, complete with a corral full of horses that adds character to a spot already brimming with a sense of the Old West. Bleary-eyed stargazers seeking daytime adventure can ride horses, hike, or go birding on any of the well-marked recreation trails.

Many Texas Star Party attendees camp on wide-open observing areas where the skies are not cloudy all day (or night). *Astronomy:* Robert Naeye

NO MORE

under star-studded skies. By Shelly Bourassa

Organizers chose Prude Ranch because it was far from city lights and busy highways where billboards and malls light the sky. The drive from El Paso is a journey into the classic desert highway movie: Shimmering heat waves distort the last-chance gas stations and widely-scattered truck stops that dot the landscape. The only thing missing is the occasional tumbleweed rolling across the highway. Trees and grass begin to appear closer to the Davis Mountains, with ranches and free-ranging cattle also becoming more frequent. Yet this outpost is a deep-sky observer's paradise, where only the forces of nature determine a good night's viewing.

Over the years, TSP organizers have successfully achieved a balance of events and activities that allow for maximizing and maintaining observing conditions. A five-mile-per-hour speed limit keeps the dust down, while lights are strictly banned after dark. Firm rules govern telescope setup.

Many individuals and clubs voluntarily contribute their time to the TSP. All volunteers belong to the Southwest Region of the Astronomical League, or SWRAL, which consists of clubs and organizations from Texas, New Mexico, and Oklahoma. Members serve on committees that handle registration and housing or organize the vendors. Others take charge of contracting for speakers, establishing awards, or arranging for blackout.

"Often people on the committees plan their vacations around TSP. It's a working week, but we still have a great time," says Jayne Lambert, a chairperson on the vendor committee. "If you're not enjoying yourself, why do it?"

TSP offers many activities throughout the week. Vendor tables and displays open for business Monday through Saturday. An astrophotography contest judges both conventional film and CCD categories. Attendees find bargains and specific observing equipment at Friday's swap meet. At the

TEXAS
STAR
PARTY

Left: The W5TSP Texas Star Party Amateur Radio Group shows its colors; Above: A Texas-sized Dobsonian waits for nightfall. Larry Slay

end of the week, a central field area displays homemade telescopes and accessories. The much-anticipated Great Texas Giveaway on Friday and Saturday nights includes everything from magazine subscriptions to eyepieces and telescopes.

Amateur astronomers who also operate amateur radios air this special event on station W5TSP (Whiskey 5 Texas Star Party). Broadcast Monday through Saturday, W5TSP offers TSP news and an eclectic assortment of music — or as Goldberg puts it, "back-to-back Bach and Metallica." And because weather is so important, observers view GOES satellite pictures and loops of cloud movement on a computer monitor during the day.

In 2000, Lambert, along with Goldberg's wife, Amelia, started a new club to spark interest in non-astronomers. "We have a novice observer club for people who have never done any observing," Lambert says. "When they find all the objects on a beginners' list, they get a pin."

Other observing programs award pins as well. The list for binocular observing includes several showcase objects. Whoever finds at least half the objects on the list receives a pin. The same requirements apply to the telescope observing list, which includes 67 globular clusters.

For advanced observers, a new program dubbed "Rings Over TSP" emerged in 2000. Contestants locate ring nebulae, ring galaxies, and polar ring galaxies. Compiled by Larry Mitchell — a member of the Houston Astronomical Society and an accomplished amateur astronomer — the ring list includes 25 elusive objects. At the last TSP, only a scant number of observers found all the ring objects. And so, in fun, Mitchell was hanged in effigy in the lecture hall at midweek. "What's the point in having an easy list for the advanced group?" he asks.

For those who welcome a difficult challenge, there is the infamous "AINTNO 100" list. This observing list was cooked up several years ago by Mitchell and another TSP organizer, Barbara Wilson, Vice President of the Houston Astronomical Society and an astronomy educator at George Observatory for the Houston Museum of Natural Science. The AINTNO list targets those who enjoy the impossible quest, or at the very least, a good laugh.

"The AINTNO list idea began when an amateur astronomer in San Antonio teased me about looking through my telescope at no-see-um's — impossibly faint objects in the sky," Wilson recalls. "It evolved into a list of 100 impossible objects everyone would love to see through a telescope, objects that are completely hopeless to find. We decided that if anyone ever did see at least one object on the list, we would issue a certificate — in black ink, on black paper."

Three objects on the list have been spotted through the years. The first — Certificate #½ — was awarded to two men for seeing Abell 37. "Larry Mitchell says that it doesn't exist because it is labeled as an IC (Index Catalogue) object, and Abell stole it from the IC," Goldberg says. "But it is on the Abell list, so Certificate #½ was issued." Certificate #1 went to the person who saw the "G" ring of Saturn.

And Amelia Goldberg won certificate #2 for spotting "the arrow that points to Pluto." ("After all," says Amelia's husband, Steve, "almost every picture you see of Pluto has an arrow pointing to the planet.")

Here's the story behind Certificate #2: During the 1999 TSP, Wilson found a piece of cardboard that looked like an arrow and jokingly labeled it "the arrow that points to Pluto." Amelia saw it, grabbed it, and waited for her chance. Finally, one morning at 3 A.M., after a confirmed sighting of Pluto, Amelia pulled out the arrow and put it on that telescope. She then announced that that this was the arrow pointing to Pluto. Although Wilson and Mitchell protested, they eventually relented and awarded Goldberg the certificate, which read: "AINTNO Certificate #2: To Amelia Goldberg and Co-Conspirators." Of course, it's written in black ink on black paper.

Since then, these three objects have been removed from the list and replaced by new ones. So how do judges know that people have actually seen objects from any of the lists,

OBSESSION
36" f/5

Left: **George Bell, of Chattanooga, Tennessee, inspects Larry Mitchell's telescope; Above: Even in Texas, fleece keeps observers comfy.** Larry Slay

especially the AINTNO 100? "You can just tell," Lambert says. "People get excited and ask those in charge of the lists a lot of questions about what they've seen."

Objects that qualify for the AINTNO list range from actual astronomical phenomena to items of pure whimsy — as the arrow pointing to Pluto indicates. More examples of the creative braggadocio include spotting the American flag on the moon, visualizing planetary nebulae in galaxy M81, counting the rings of Uranus, or witnessing comets in the Oort Cloud (which would be about 60th magnitude — a trillion times fainter than the faintest objects ever detected). All searching must be done visually — no CCD imaging or film allowed. TSP's dark-sky location facilitates this process.

Still, some factors have increased skyglow in the area. Wild fires created problems one year for TSP, and an increase in the area's population is also having an adverse effect. Of more concern is the air pollution from a plant in Mexico, which has affected the pristine skies, although the Milky Way is still seen as a pale river of light. In spite of these problems, TSP's organizers remain optimistic about the seeing conditions at Prude Ranch and the future of TSP. Organizers have also worked hard to combat light pollution in nearby towns such as Fort Davis, Alpine, and Marfa. On a larger scale, they've made statewide inroads to control light pollution.

"There is now a Texas state law that says all state projects with outdoor lighting must be shielded," says Goldberg. "Many TSP attendees and organizers were part of helping get that law passed. And the TSP Light Reduction Project has also been a big success," he says. "We raised well over $20,000. With this money, we replaced all the public street lights in Fort Davis with properly shielded fixtures, and we purchased shields for the mercury vapor lights. The local power company cooperates in this endeavor, and McDonald, as you can guess, is very supportive of our project. 'Before and after' pictures show an obvious effect on the night sky."

Both Goldberg and Wilson say that the efforts against light pollution are definitely winning. Cooperation from nearby towns will continue to be a major help in the future as the population grows — a comforting thought, given that Fort Davis is only five miles away. Regarded as the highest town in Texas at 5,050 feet, Fort Davis eagerly welcomes star party guests with down-home and historic accommodations, such as the Hotel Limpia.

Fort Davis celebrates its West Texas heritage as it strives to maintain a semblance of old Texas authenticity. Refreshingly, it does so with genuine hospitality for visitors.

Attractions in the Fort Davis area include the Fort Davis National Historic Site, the Chihuahuan Desert Research Institute and Visitor Center, the Davis Mountains State Park, and the 75-mile Scenic Loop. Tourists can also ride the TSP-sponsored bus to the McDonald Observatory for a tour of the facilities housing the 107-inch Harlan J. Smith Telescope as well as the famous 11-meter Hobby-Eberly Telescope — currently the largest optical telescope in the world.

Travelers wishing to include excellent deep-sky observing during their next vacation should consider attending the TSP. With a week full of activities from May 13 to 20, 2001, the promise of great weather, and plenty of interesting sightseeing attractions, TSP offers something for everyone. As Lambert puts it, "TSP is summer camp for adults." ▣

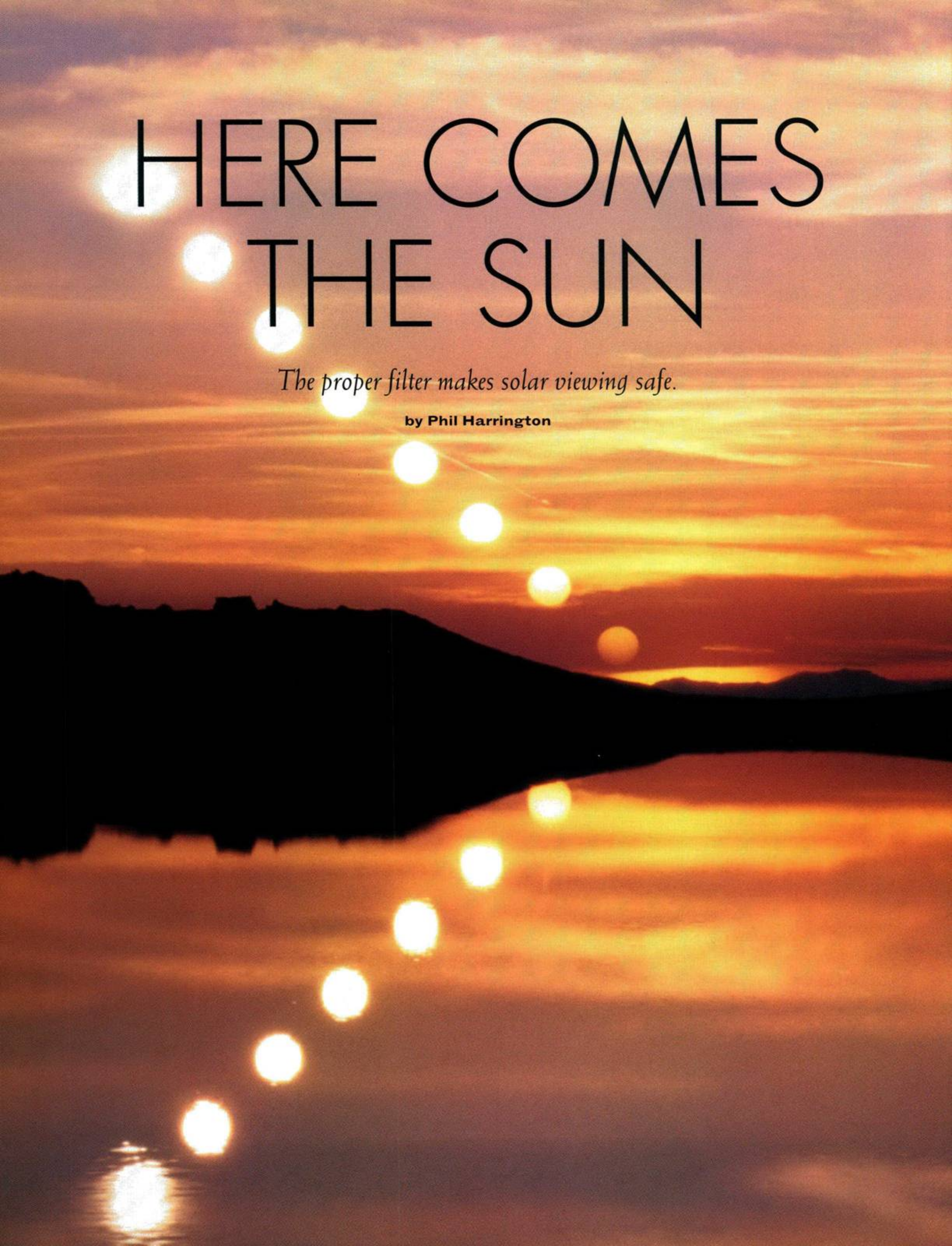
Shelly Bourassa attended the TSP for the first time in 2000. She is a chemist and a graduate student of journalism at Marquette University in Milwaukee, Wisconsin. This is her first article for Astronomy.

For more information on the TSP, including its history, speakers, events, accommodations, and fees, go to www.metronet.com/~tsp/. Check out Fort Davis information at www.fortdavis.com. Visit the Prude Ranch website at www.prude-ranch.com.

HERE COMES THE SUN

The proper filter makes solar viewing safe.

by Phil Harrington



There's one rule that everyone learns as a child: Never look at the sun. Simple. Straightforward. It works for most people their entire lifetime. And then there are astronomers. We insist on observing our nearest star despite the risks involved. It's the old conundrum of look at it, but don't look at it. There must be a way out of this.

Actually, there is. We have the technology that makes direct solar observing possible: Seasoned solar observers use solar filters.

Safely speaking, the only acceptable type of solar filter fits over the front of your telescope or binoculars. This reduces dangerously intense solar rays to a safe level prior to entering the telescope and your eyes. Remember — never place the filters between you and the eyepiece.

Solar filters are made from either glass overcoated with a metal layer or a thin, polymer film, such as mylar. Aesthetically, glass filters appear superior to the comparatively flimsy-looking film filters. But solar filters are meant to be looked through — not at.

Most manufacturers sell premounted filters designed for specific telescope models. These slip over the front end of the telescope and are full aperture filters, so the larger the telescope, the more expensive the filter. Because a telescope's full aperture is not required for solar observing, you can save a few dollars by purchasing a small, unmounted filter and then mount it using an off-axis mask. This homemade alternative not only lowers the price, but also reduces both resolution and aperture size.

Opposite: Fabrizio Melandri caught this time-lapsed sunset over Lake Scaffaiolo, Italy. This page, clockwise from center: Identi-View Class A; homemade Baader; Solar Skreen; Polymer Plus and Type 2 Plus. Bill Zuback

THE FILTERS

Mounted filters are available for more than 50 specific telescope models, ranging from 60mm to 14 inches in aperture. I reviewed examples from four leading manufacturers: Baader Planetarium, JMB, Inc., Roger W. Tuthill, Inc., and Thousand Oaks Optical. Tuthill, the oldest of these firms, began selling Solar Skreen filters in 1973. Solar Skreen filters consist of two tissue-paper thin pieces of aluminized mylar material held together in a cell made from PVC piping.

Slip the solar filter cell over the front of your reflecting telescope or over your reflector's dew cap. Tighten the thumbscrews. As advised in the instructions for the Solar Skreen, never pull a polymer-film solar filter taut. Mount it so that it flaps slightly; stretching spoils its optical quality.

Thousand Oaks Optical, another established name in the solar filter field, offers both glass and non-glass filters. Its Type 2 Plus filters are made from float glass, similar to window glass. Pat Steele of Thousand Oaks says that each piece of glass used for a Type 2 Plus filter is hand-selected.

Mounted Type 2 Plus filters for telescopes range in size from 2 to 14 inches. (Thousand Oaks plans to introduce a new series of filters made from glass that has been polished to a flatness of ¼ wave. These were currently unavailable for testing.) Type 2 Plus filters are coated with "Solar II Plus," a patented mixture of chrome, stainless steel, and titanium.

Thousand Oaks Optical also sells the Polymer Plus model, a non-glass solar filter made from relaxed polymer film material coated with "Solar II Plus." Polymer Plus filters are available in the same sizes as the Type 2 Plus. Additionally, Thousand Oaks sells a "Black Poly" filter designed for binoculars and finderscopes only (the film tends to blur high-power views, but is suitable for low-power viewing).

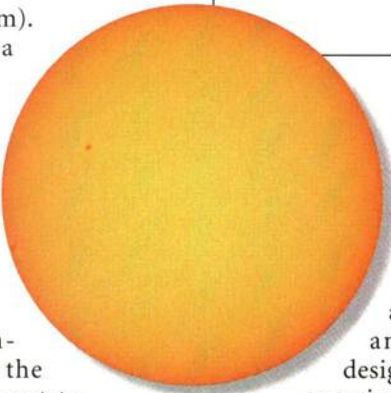
Although JMB, Inc. offers three different glass filters, Class A, Class B, and Class C, I tested only the Identi-View Class A filter. It comes mounted in a machined aluminum cell accented with a blue "racing stripe" around its circumference. JMB states that all of its filters are made of machine-polished float glass coated with an alloy of nickel, chromium, and stainless steel.

THOUSAND OAKS OPTICAL TYPE 2+
THOUSAND OAKS OPTICAL
SOLAR SKREEN

(Orion Telescope Center also carries these filters.) JMB's remounted filters fit telescopes ranging in aperture from 2 to 14 inches.

Baader Planetarium in Germany is a newcomer among solar filter manufacturers. Its Astro-Solar filter consists of a polymer film that is not only darkened to reduce internal reflection, but also heat-annealed (like glass) to lessen internal strains. The filter then undergoes an ion implantation and metallization coating process. Astro-Physics imports the Baader solar filter material and sells it as raw sheets, measuring roughly 8" x 11.5" (200mm x 290mm) or 20" x 40" (500mm x 1,000mm).

Buyers must build a cell to hold the filter in place, either by following the included instructions or by using their own ingenuity. While the filter material itself is quite tough, it requires gentle handling. Never crinkle the film, and take care not to touch it except along its edges. Although the homemade cell won't be as aesthetically elegant as the others tested, it works fine and costs far less. For those who don't do well with arts and crafts, Kendrick Astro Instruments recently began selling premounted Astro-Solar filters. Celestron offers it in cells for their own telescopes.



EASY SET UP

Each filter was sized to fit my 4-inch f/9.8 refractor — my telescope of choice for solar viewing. I compared filters directly to see how each showed various solar features. In order to minimize the effect that my local observing conditions might have on the comparison tests, I performed them repeatedly in quick succession and only on days of steady atmospheric conditions with little wind. I set up the telescope in a grassy yard to avoid locally turbulent seeing conditions caused by heat radiating from concrete.

All of the filters (including my home-mounted Baader) slid over my refractor's dew cap. I found the slightly oversized Tuthill cell easiest to mount and secure. Three equally spaced nylon thumbscrews tighten against the dew cap. The JMB cell has a strip of adhesive-backed foam rubber around its inside circumference that slips smoothly and easily over the dew cap. Thousand Oaks uses adhesive-backed felt as an inner lining. This design works, but the felt may rip or fray if the fit is too tight. It comes with extra felt material for a slightly better fit, if needed. Since each Baader filter is homemade, the quality of the cell differs with the user.

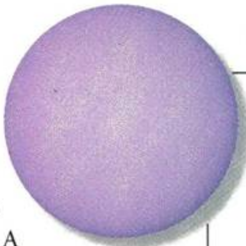
Thousand Oaks Optical

Box 4813 • Thousand Oaks, California 91359
(805) 491-3642 • Fax: (805) 491-2393
http://www.thousandoaksoptical.com

Filter name: Type 2 Plus
Material: Glass coated with Solar II Plus
Image Color: Yellow-orange/black background
Diameters: 19 sizes from 2" to 14"
Price: From $60 – $160
Comments: Very good sunspot detail. Faculae visible, but with less contrast than others. Secured with adhesive-backed felt.

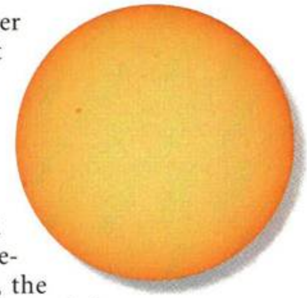
Filter name: Polymer Plus
Material: Polymer coated with Solar II Plus
Image Color: Yellow/yellow-black background
Diameters: 14 sizes from 2" to 8"
Also available unmounted.
Price: From $50 – $150
Comments: Excellent sunspot detail, though slightly less clear than Baader. Secured with adhesive-backed felt.

COLOR DIFFERENCES



The most obvious difference between the filters is the color of the image. The JMB Class A and Thousand Oaks models show the sun as a yellowish disk. The Baader filter turned the image white, while the Tuthill Solar Skreen displayed a bluish-white sun. None of these represent the sun's "true" color; the sun's color depends on the type of coating used, and different coatings accentuate different features on the sun. As with nighttime observations, image contrast is key.

All of these filters are rated at Neutral Density 5, which reduces the sun's intensity to only 1/1000th of one percent — the accepted filtering density for visual observations. I discovered that the Baader filter produces a noticeably brighter image than the others. I felt the sun's image appeared somewhat brighter (although not dangerously so) when used at 38x (26mm eyepiece), but it looked fine when magnified to 142x (7mm eyepiece). However, the other filter models tended to dim images at higher powers. So, like an old-time photographer, I draped a black cloth over my head for a good view.



All of the solar filters reviewed show the sun's photosphere, the

Roger W. Tuthill, Inc.

Box 1086 • Mountainside, NJ 07092
(908) 232-1786
Fax: (908) 232-3804
http://www.tuthillscopes.com

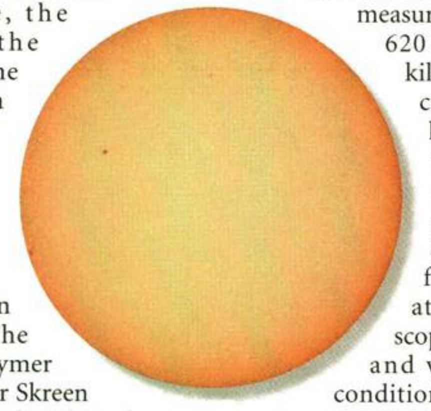
Filter name: Solar Skreen
Material: Polymer
Image Color: Blue-white/blue background
Diameters: Unmounted to fit telescopes from less than 4" to 14"
Mounted filter in cells, sizes fit more than 50 specific telescope models
Price: Unmounted: $30 – $125; Mounted: $48 – $175
Comments: Excellent sunspot detail, though slightly less clear than Baader. Lower image contrast than Baader. Best on faculae and granulation. Most secure cell.

lowest of three layers that comprise the solar atmosphere. None is designed to display solar prominences or flares. Viewing those dramatic solar events requires expensive hydrogen-alpha solar filters. (See *Astronomy*, January 2001.)

For most amateur astronomers, the biggest attraction when observing the sun's photosphere is watching the ever-changing array of sunspots. These transitory features appear in unusually strong regions of the sun's magnetic field. Each spot has a very dark central portion called the umbra, surrounded by a lighter penumbra. Sunspots often form in groups, with the largest spanning several Earth diameters across.

TEST RESULTS

All the filters produced very good views through my 4-inch refractor at low and moderate magnifications, with a wealth of fine structural details within major sunspot groups. Raising the stakes some with a 7mm (143x) eyepiece, the Baader reveals the greatest level of fine detail, especially in both umbral and penumbral regions of large sunspot complexes. JMB's Class A filter shows slightly less penumbral structure than the Baader filter. The Thousand Oaks Polymer Plus and Tuthill Solar Skreen reveal a bit less detail and tie for third place. A close fourth goes to the Thousand Oaks Type 2 Plus. All-in-all, the differences among them were minor.



JMB, Inc.

736 Oak Glen Circle
Fall Branch, TN 37656 • (423) 348-8883
Fax: (423) 348-6389
No website available.

Filter name: **Identi-View Class A**

Material: **Machine-polished glass**

Image Color: **Pale yellow/black background**

Diameters: **10 sizes for 2" to 14" telescopes**

Price: **From $40 – $190**

Comments: **Excellent sunspot detail and image contrast. Cell held in place by friction thanks to an adhesive-backed foam-rubber strip. Easy fit, snug attachment.**

Solar filters also display brighter areas of the photosphere called faculae, hot regions that lie hundreds of miles above the visible photosphere. Look for faculae along the edge, or limb, of the sun, where their contrast is greatest thanks to an effect known as limb darkening.

Since faculae are hotter and slightly bluer than the photosphere, the bluish-white filtering effect of the Tuthill Solar Skreen best accentuates their detail. Solar photographers who wish to see a yellow sun when using a Solar Skreen filter should add a Wratten deep-yellow No. 15 or orange No. 21 filter to the eyepiece, or the film will automatically shift the color to a more "natural" tint.

Close-up studies of the photosphere reveal a myriad of tiny grains called granulation. Each granule, measuring between 450 and 620 miles (700 to 1,000 kilometers) across, is a convective cell of heated gas. Since these phenomena measure only a few arcseconds across, spotting granulation from Earth requires at least a 3-inch telescope, 150 to 200 power, and very steady seeing conditions. The Solar Skreen shows granulation the clearest, most likely because of its blue filtering effect. While faculae and granulation are best seen through the Solar Skreen, scattered light turns the surrounding sky a milky blue color.

The JMB Class A and Thousand Oaks Type 2 Plus glass filters produce a jet-black background. The Baader filter shows a dark-gray background and the Thousand Oaks Polymer Plus projects a dark-gray/yellow surround. Although I have heard some observers complain of a yellow-green edge to the sun through the Polymer Plus, I saw no evidence of that effect.

FINAL RATINGS

The Baader Astro-Solar filter impresses me both for its amazingly low price (as much as 60 percent lower than the others) and for its resolution of sunspot detail, especially at higher powers. I feel that other filters show comparatively dimmer images. One caveat: Baader requires assembly.

Baader Planetarium

c/o Astro-Physics, Inc.
11250 Forest Hills Rd.
Rockford, IL 61115
(815) 282-1513
Fax: (815) 282-9847
http://www.astro-physics.com

Filter name: **Made from Astro-Solar Film**

Material: **Polymer**

Image Color: **White/gray background**

Diameters: **Sold in unmounted sheets only; comes with mounting instructions.**

Price: **8.0" x 11.5": $30; 20" x 40": $70**

Comments: **Brightest image of all. Excellent sunspot detail and image contrast. Faculae visible along limb; washed out elsewhere due to image brightness. Bargain price.**

The JMB Identi-View Class A also shows a good amount of sunspot structure. Observers looking for faculae and granulation will find that Tuthill's Solar Skreen outdoes the others quite handily.

If you plan on showing the sun to the public or school groups on a regular basis, I recommend the Thousand Oaks Type 2 Plus. It produces the yellow-orange sun that everyone expects to see.

So go ahead and look at our unique solar center. It's the only star that we can study up close, and it forms the basis for much of what we know about distant suns and stars in other galaxies.

Just remember that the sun is the only celestial object that actually causes us physical harm. Unprotected viewing or use of an improper filter can lead to permanent eye damage and even blindness. By following proper safety precautions and using a qualified solar filter, amateur astronomers can enjoy many pleasant days watching the action unfold on the ever-changing face of our star. **A**

Phil Harrington has studied the stars for more than 30 years. He is the author of several books on astronomy, including Touring the Universe Through Binoculars Atlas, *on CD ROM. Visit his website at http://philharrington.homepage.com.*

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> My order was received three days faster than the suggested arrival time, in excellent condition. Your "help desk" was essential in helping me make choices, as we are not in a major metro area. We cannot visit a quality optics shop in order to make informed choices. Please thank your technical help staff for their excellent suggestions and patience with my questions. I am very pleased with your products. I hope we will be doing business with you again.
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Apogee LISÄÄ	guider+color	2690^{00}
Apogee LISÄÄ	guider+megapixel	3890^{00}
Apogee LISÄÄ	guider+megapixel color	3890^{00}
Meade 201XT	autoguider	395^{00}
Meade 208XT	autoguider or camera	495^{00}
Meade 216XT	16-bit camera	695^{00}
Meade 416XTE	camera/guider set	1995^{00}
Meade 1616XTE	camera/guider set	6495^{00}
SBIG ST-4	autoguider or camera	890^{00}
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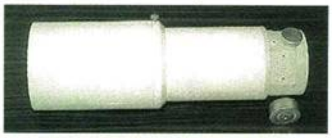
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A 4" computerized go-to Mak for $699!

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NS4

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ask Astro

Hollywood Planets, Maks vs. SCTs, Amateur Interferometry

I've seen several Hollywood movies that depict planets with twin suns. Is this physically possible? If so, what type of orbit would a binary system's planet(s) possess? — *Christopher Brown, Enid, Oklahoma*

According to current theoretical research, two classes of stable planetary orbits are allowed in binary star systems. In one case, a planet may orbit one star of the binary, as long as the other star is at least three times farther away from the parent star than the planet. (The exact cutoff distance actually depends on the masses and orbits of the stars in the binary). This is the type of extrasolar planet discovered around 16 Cygni B.

The other type of stable orbit occurs when a planet circles both stars of the binary. In this case, the planet has to be at least three times farther from the stars than they are from each other. Astronomers think they've actually discovered such a system through gravitational lensing effects. Furthermore, this is the type of planetary system that my colleagues and I are searching for around CM Draconis and nine other close binary systems (see "Discovering Worlds in Transit," March 2001).

A star's Circumstellar Habitable Zone (CHZ) is defined as the orbital distance at which liquid water may be maintained on a planetary surface. Considering the seemingly ubiquitous 3-to-1 ratio required for stable planetary orbits, it seems plausible that stars separated by up to three times their mutual CHZ distance might harbor habitable planets.

About half the stars in the Milky Way likely reside in binary systems, so it's a good thing for exobiological as well as SETI searches that such stable planetary orbits may exist. — *Laurance Doyle, SETI Institute*

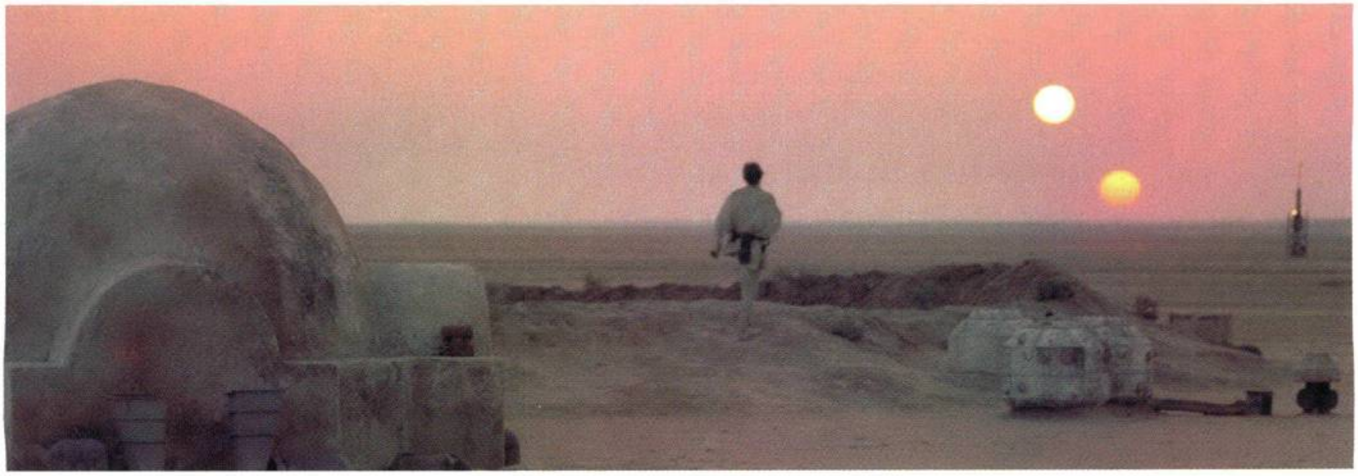
I've noticed that the Milky Way runs nearly perpendicular to the ecliptic. Does this mean that Earth orbits the sun perpendicular to the galactic plane? — *Michael Kruse, Chicago, Illinois*

In short — yes. But perhaps you were looking for more detail.

Most of us are comforted by the sense of order we find in the solar system. All of the planets (except Pluto) orbit the sun in roughly the same plane — called the ecliptic. In fact, the moons of the planets stick fairly well to that plane too. But this was no accident: Astronomers believe that the solar system was born from a rotating gas cloud, which collapsed to create the sun and a thin disk of leftover material. All of the planets formed from that disk, so it's perfectly natural that their orbits should lie in the same plane.

Astronomers also believe that the Milky Way Galaxy resulted from the collapse of a much larger cloud of gas and dust, creating its familiar disk structure in the process. We simply define the galactic plane as the plane of the Milky Way's disk.

The protosolar gas cloud probably orbited the center of the Milky Way in the galactic plane. Still, the Galaxy's non-radial, gravitational influence —



Fact meets fiction on a planet with twin suns.

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The Milky Way regularly reveals its bias to impartial nighttime observers. Jerry Schad

the tendency to pull the gas cloud above or below the plane or to rotate and twist the cloud in its orbit — was likely very small. The protosolar cloud was free to collapse with any number of random orientations. As fate would have it, the ecliptic came to rest with a significant inclination, tilted by about 60 degrees to the galactic plane — not quite perpendicular, but a rather large angle nonetheless.

This means that the two planes (the galactic plane and the ecliptic) intersect at two locations — near Taurus on one side of the sky and Sagittarius on the other. By coincidence, Sagittarius also points toward the galactic center. Sometimes you can even see the planets appear to move across the distant center of the Milky Way.— *Phil Plait, webmaster, www.badastronomy.com*

What's the difference between a Maksutov-Cassegrain and a Schmidt-Cassegrain telescope? Is one better than the other for a casual observer? — *Gary Haley, Barstow, California*

The biggest difference between these two classic scopes is in the way that they direct light back into the eyepiece, via a secondary mirrored surface located on the front corrector plate of the telescope.

The secondary mirror on a Schmidt-Cassegrain (SCT) may be adjusted with screws to tweak light-path alignment. Consequently, transporting your SCT might knock it out of optical alignment. A Maksutov-Cassegrain (Mak), on the other hand, doesn't have a secondary mirror, but rather a patch of reflective aluminized coating on the underside of its glass corrector plate. This means that secondary alignment will always be tried and true, which adds to the Mak's overall durability.

Apart from this imminently practical consideration, Maks also yield higher power for a given set of eyepieces when compared to an SCT of the same aperture. But corrector plates in Maks also tend to be a bit thicker, which makes them heavier than similar-sized SCTs.

Other than subtle functional differences, when it comes to optical quality, these two telescope designs yield practically the same view of the sky. — *John Shibley, contributing editor*

How long will it be before optical interferometer technology becomes part of amateur astronomy equipment? — *Dave Davenport, Bedford, New Hampshire*

Optical interferometers are still very challenging to build and operate. All current interferometer installations typically require a very close collaboration between astronomers and engineers to keep things running smoothly. Moreover, the task of "data reduction," the process by which astronomers combine many interferometric measurements to produce clear, high-resolution images, is also very complex and requires sophisticated computers and software.

So, the short answer is that amateurs will probably not replace their traditional telescopes with interferometers any time soon. Nevertheless, demonstrating the principles of interferometry using real stars is certainly within the reach of experienced amateurs.

Albert Michelson, the first American to win the Nobel Prize in physics, used an interferometer to measure the diameter of Jupiter's moons in 1891. And German astronomer Karl Schwarzschild turned his telescope into an interferometer to measure close binary stars in 1896. When Albert Michelson returned his attention to astronomy in 1921, he and his colleague F. G. Pease successfully measured the diameter of the red giant star Betelgeuse.

With recent progress in telescope design and modern electronics, it might take a little longer, but probably not a hundred years, before amateurs are building their own imaging interferometers. — *Rudolf Danner, NASA's Jet Propulsion Laboratory*

Zeta Gem's distance is now well-known, thanks to interferometry. Bill and Sally Fletcher

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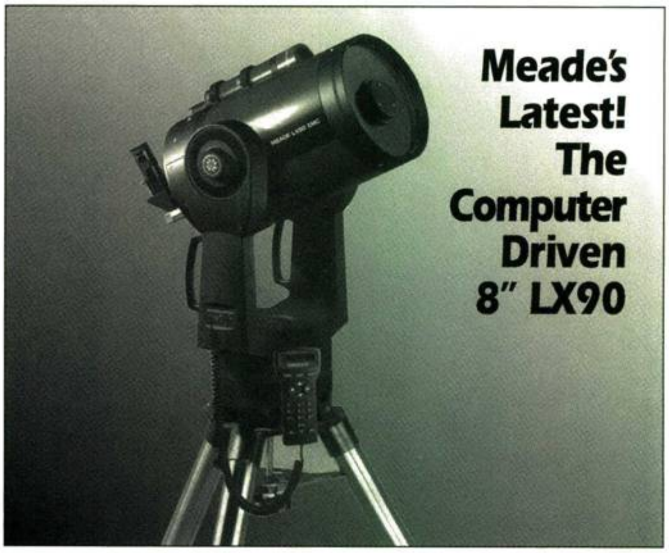

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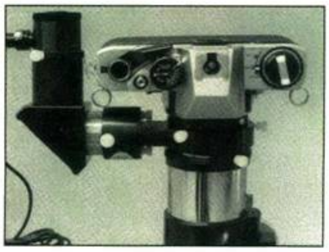

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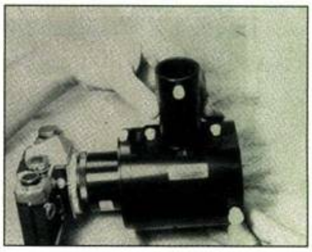

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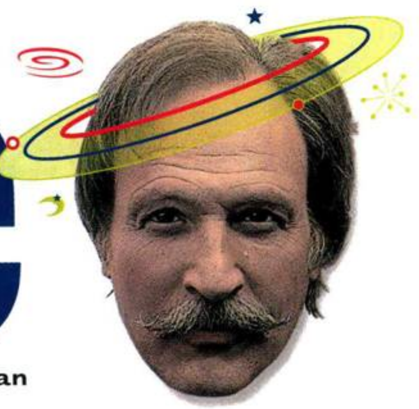


by Bob Berman

Vega — or Vanessa?

It's a common experience. You're absent-mindedly listening to the radio when something snaps you to attention. In my case I heard the announcer say, "If you're looking for a perfect gift for that special someone . . . then have a star named after them!"

The amazing thing to me was that the International Star Registry, the advertiser, was still in business. More than 20 years ago, when I first saw their ads, I thought Ira Downings of Toronto, the person behind it, would make a quick buck and then vanish. I was wrong. After he sold the franchise to U.S. entrepreneur Phyllis Mosele, the now Illinois-based outfit grew bigger than ever, especially after adding radio commercials.

First in the cosmic name-peddling market, ISR has dispensed more than a half million stars since the enterprise began in 1979. It's so lucrative that its lawyers have to fend off other star-naming wannabes, giving new meaning to name-calling fights.

April is not their busiest month, according to general manager Mary Ellen Mottyka; they peak during Christmas holidays and Valentine's Day, and no surprise: The gift is both impressive and romantic. It lets you turn to the person you love, sweep your hand toward the heavens and declare, "Up there, sweetheart, is a star that now bears your name forever." Talk about scoring points! But you can't gesture too precisely, since the star they give you is dimmer than 11th magnitude and not even visible through binoculars; they ran out of naked-eye stars decades ago. Still, if you have some knowledge of the constellations, at least you can point in the correct general direction.

Fools and lovers may buy into it, but the New York City Department of Consumer Affairs is less starry-eyed. In 1998, it issued a violation notice to the International Star Registry for engaging in a "deceptive trade practice." You're not supposed to sell something you don't own, and the ISR is not an astronomical body of any kind, let alone the one that officially names things. That authority belongs to the IAU, the International Astronomical Union. To that staid organization, name-selling is about as appealing as renaming the planets after Simpsons characters. But the average person doesn't know this.

Day after day, thousands of customers respond to ISR ads that strongly impart an aura of authenticity. They promise that your name will be copyrighted, protected in a vault, and that the star bearing your name is "located using information that guides the Hubble Space Telescope." For $48, purchasers receive a one-page star chart with a single dot circled. They also get a fancy parchment proclaiming that henceforth, this star will be known as "Brittany," "Charlie," or whatever. Not too long ago, the certificates also claimed inclusion in the Library of Congress, until the company was prohibited from saying that. Even so, it all seems as permanent as the firmament itself.

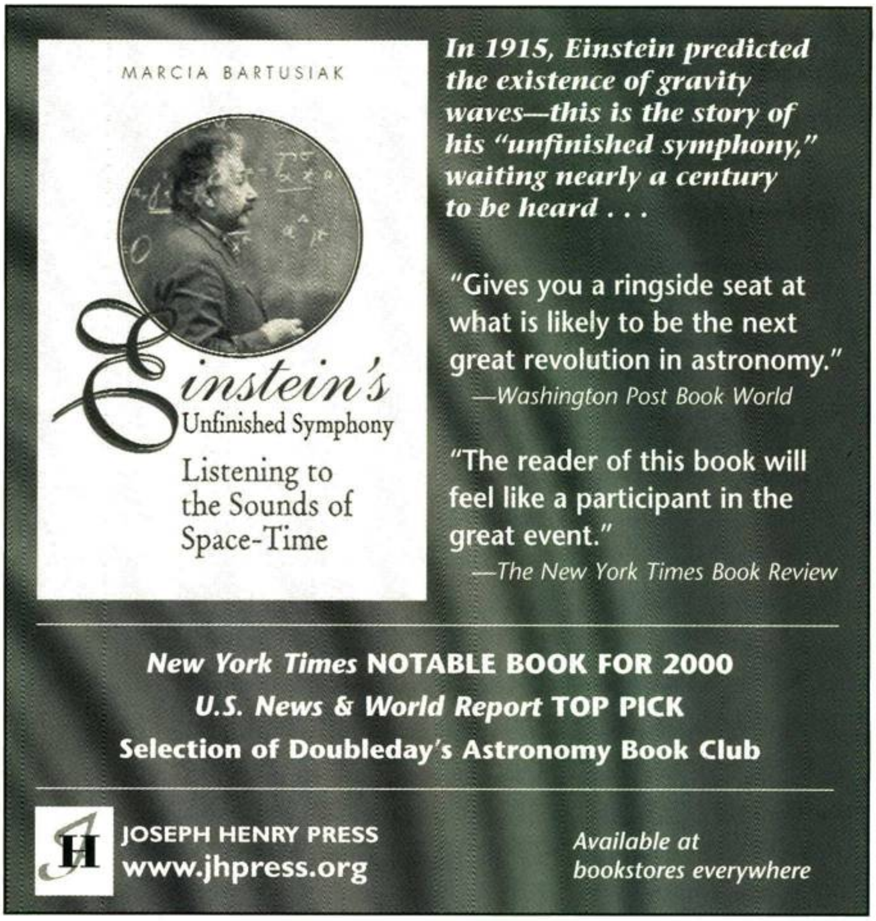
Of course, one little thing is missing, as the New York consumers watchdog agency observed. No astronomer, observatory, actual star atlas, or anybody remotely connected with astronomy will ever call this star Jessica, even if it explodes into a supernova that gains worldwide attention. Every astronomer and all the media will still refer to it as HDE337962. Who, then, will identify the star with your name? Only the ISR company.

The reason the ISR can stay in business is that there really is no law against renaming things, as long as you avoid trademarks or exploiting celebrity names. Indeed, I think this magazine is neglecting a wonderful potential sales pitch by not offering to name an entire galaxy after each new subscriber. And why not? There are 200 billion of them; most have no designation at all. Anyone is allowed to call anything anything. So, while it's still legal, let me offer you a much better deal than the ISR company. Send in a mere 20 bucks and my observatory will allude to the sun with your name. Then you can throw open the curtains each morning and announce, "Tom has risen!" Why settle for an 11th magnitude star when I'll bestow your name on an object that you can not only see, but which helps you see.

New cosmic entrepreneurial opportunities seem as limitless as the expanding universe. Why isn't anyone selling entire celestial bodies instead of merely their names? One Christmas long ago, my parents gave me a framed "official title" to one acre of land on the moon, a popular gift at the time. I treasured that certificate for years. Only later did I finally realize, with the slow-wittedness that my friends assure me I still possess, that it was just a gag. And that's the difference: I probably could get away with trying to sell you the sun because everyone knows I don't own it. (Even if you did buy it, where would you keep it?). The reason the ISR irks the science community is that the company's official-sounding name, together with the implication of legitimacy suggested by their ads, implies that the new star name will be accepted and used by astronomers, and that just ain't so.

Millennium after millennium, it's always been "buyer beware." The new wrinkle is "name buyer beware." But I'm surprised the IAU remains too stodgy to jump on this lucrative bandwagon. Think of the research that could be funded if the world's only legitimate star-naming body sold off its star names. They currently bestow on stars a stupefying letter-and-number designation. The stars could hardly be harmed by naming a few of them after Jennifer or Courtney. We could use some fresh names out there. It's pretty unimaginative that the magnificent rings of Saturn are named A, B, C, and so on, and that Jupiter's ancient, violent, Earth-dwarfing cyclone is called "The Red Spot." There's always been a yawning gap between the epic, lunatic architecture of the universe and the dreary logic of our designations. It wouldn't hurt to have a few poets on the IAU's naming committee. In any event, the current name-selling business simply reflects ordinary marketplace forces where Caveat Emptor has always ruled. Some believe that the star-name gift is so romantic its lack of authenticity is unimportant. Others who feel taken for a ride can use the ISR company's full-refund guarantee. No harm in either case. Only those customers who are clueless about how stars are actually named may be taken aback. This may be a good time to break the news to them — along with a little message obtained by looking back over this page and linking the FIRST WORD of each paragraph. ■

Bob Berman, our regular Strange Universe columnist, has written several books, including Secrets of the Night Sky.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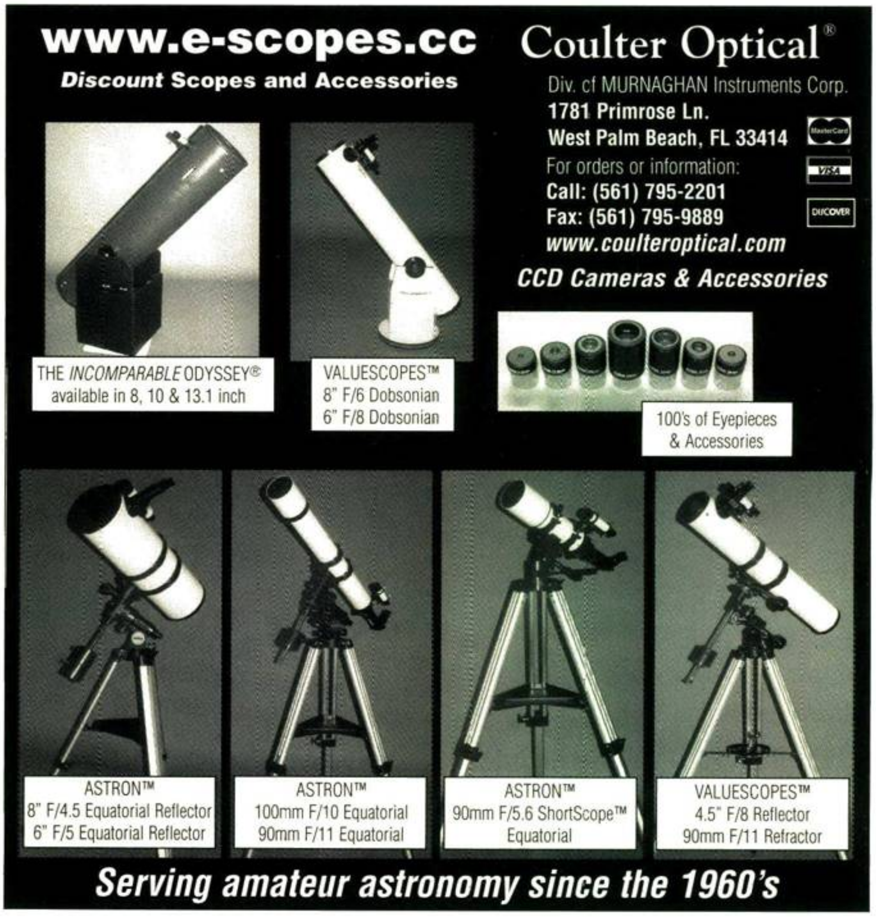
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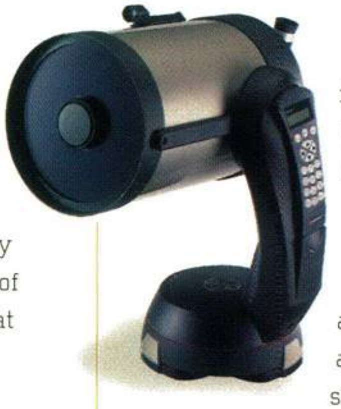
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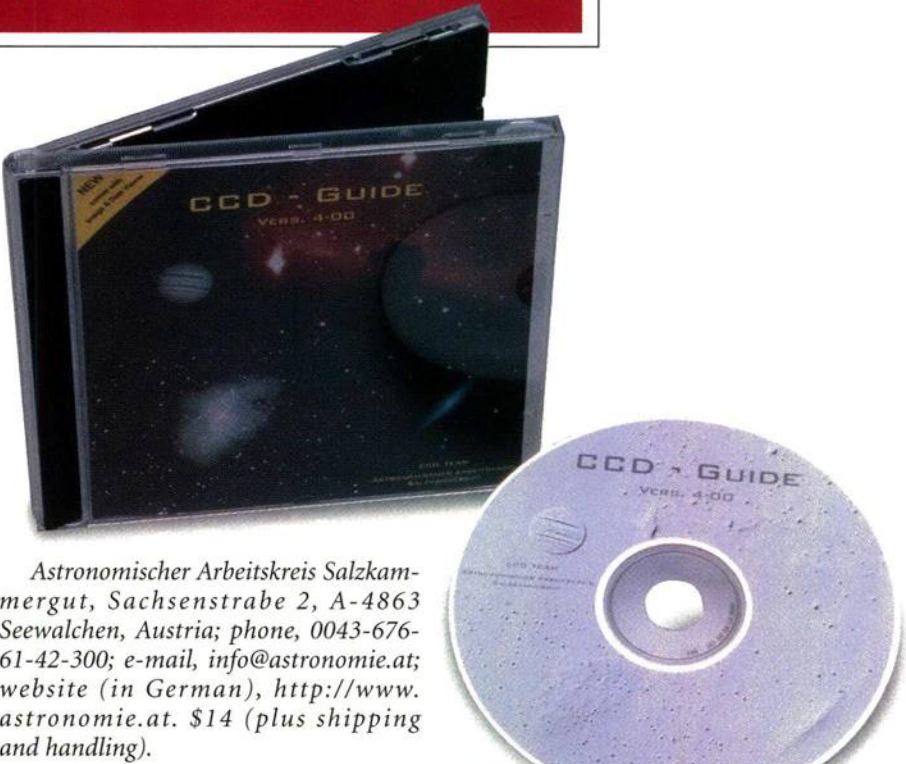
STAR STUFF

PRODUCTS

CCD Guide

▶ A group of amateur astronomers is raising money to refurbish the Gahberg Observatory, an astronomy club facility in Austria, by selling a reference CD-ROM with 606 images of 500 astronomical objects. Club members created the images with telescopes smaller than 14 inches that were equipped with digital cameras.

An easy-to-use self-programmed viewer allows users to compare their CCD images to those on the CD-ROM. Each astronomical object photographed comes with the name of the photographer, the equipment used, and other information in English and German. The CD also can be used as an observation-planning tool.

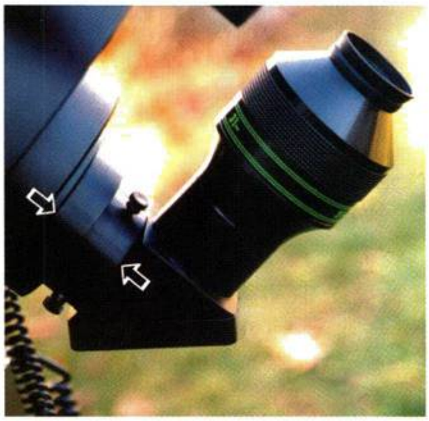


Astronomischer Arbeitskreis Salzkammergut, Sachsenstrabe 2, A-4863 Seewalchen, Austria; phone, 0043-676-61-42-300; e-mail, info@astronomie.at; website (in German), http://www.astronomie.at. $14 (plus shipping and handling).

Eyeopener

▶ Great telescopes merit great eyepieces; however, in some cases, little-known restrictions in the optical system prevent users of some large-aperture telescopes from taking full visual advantage of the superb 2-inch eyepieces that have recently become commercially available.

As Schmidt-Cassegrain Telescopes (SCTs) evolved from 8-inch models to larger-aperture scopes, the "Schmidt-thread" couplings used for securing 1¼-inch diagonals and eyepieces to telescope backplates remained mostly unchanged. This coupling mechanism functions as a 1½-inch-diameter field stop. A newly designed 2-inch-diameter adaptor called an Eyeopener (shown between the arrows in the accompanying image) replaces the 1½-inch opening at the back of Meade 10-inch and 12-inch SCTs.



The unrestricted optical path of the Eyeopener eliminates the vignetting — reduced illumination at the edges of the image plane — associated with connecting 2-inch optics through the Schmidt-thread coupling.

The compact, close-tolerance, black-anodized aluminum back screws onto the scope's 3¼-inch backplate threads and accepts a 2-inch diagonal tube or direct mounting of a 2-inch eyepiece. Three nylon thumbscrews secure the optics.

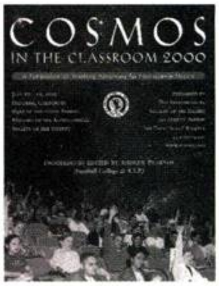
Peterson Engineering Corp. Sky Division, 405 New Meadow Rd., Barrington, RI 02806; phone, (888) 712-9332; website, www.peterson-web.com. $99.95 plus shipping and handling.

PRODUCT INFO

Suppliers should send announcements and color photographs to Star Stuff, P.O. Box 1612, Waukesha, WI 53187, or e-mail starstuff@astronomy.com. *Astronomy* assumes no responsibility for the product information supplied by manufacturers. Prices are retail and subject to change without notice. Check *Astronomy*'s website for further product updates — http://www.astronomy.com

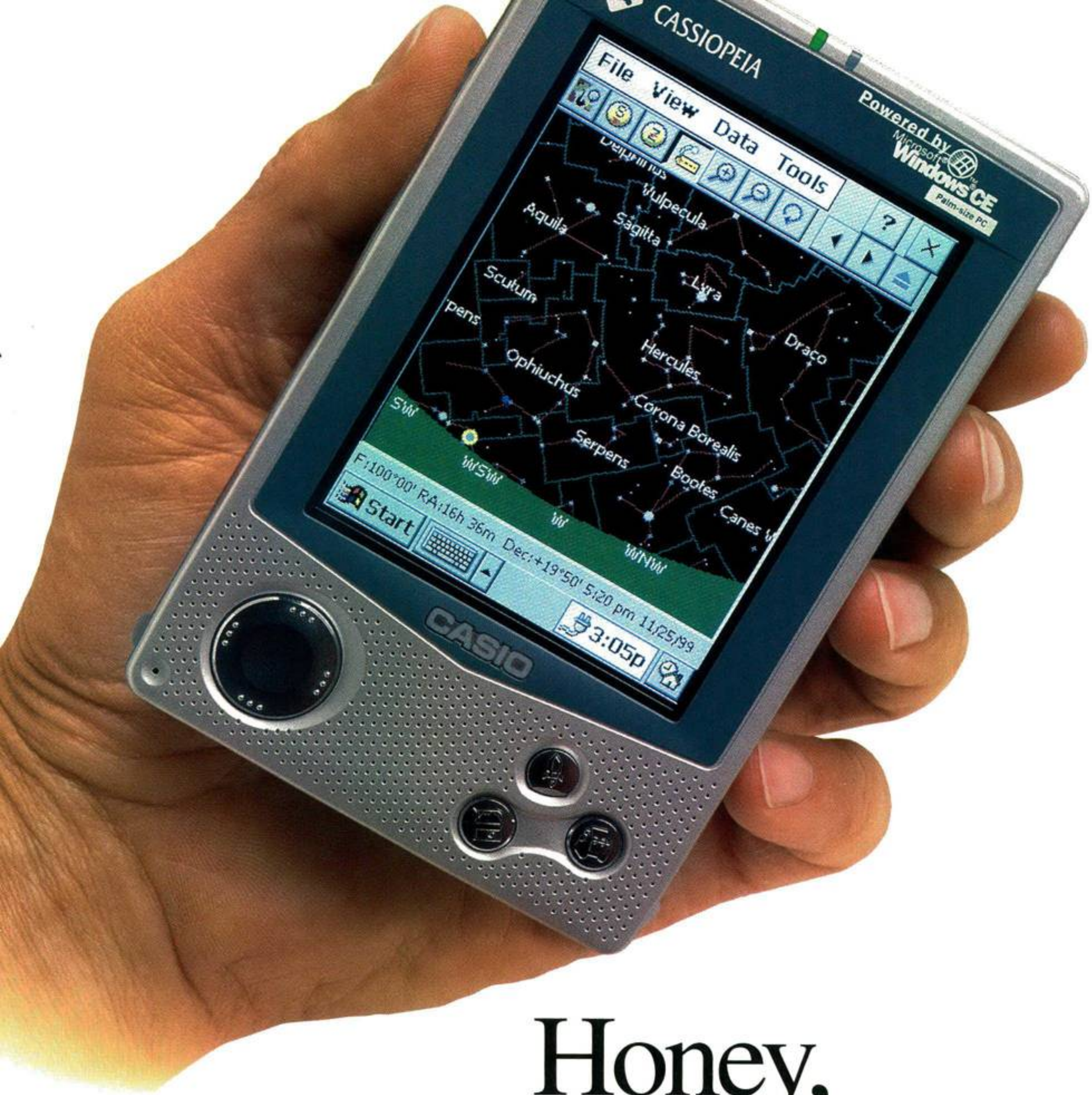
Cosmos in the Classroom 2000

▶ Introductory college courses on astronomy for non-science majors can be tough assignments for teachers. The Astronomical Society of the Pacific is offering help with a 334-page loose-leaf book that covers everything from practical advice on how students learn to ways of responding to creationism. The book is a product of a meeting in 2000 that was sponsored by the American Astronomical Society with support from the National Science Foundation and NASA.



Experienced astronomy instructors as well as newcomers to astronomy teaching can benefit from the 81 papers included in the reference work. Many of the materials and guides were published for the first time in the book and are not available elsewhere.

Astronomical Society of the Pacific (Cosmos 2000 Offer), 390 Ashton Ave., San Francisco, CA 94112; phone, (800) 335-2624; website, http://www.aspsky.org. $29.95 (California residents, add sales tax; outside the U.S., add $5 for shipping.)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A BOOKS

Space Explorer Series

Raintree Steck-Vaughn Publishers, Austin, TX, 2001; each of the 64-page hardcover titles is $28.54. (The four-book set is $114.16.)

Signals from Space: The Chandra X-Ray Observatory

Robert Naeye, ISBN 0-7398-2215-2.

Star Factories: The Birth of Stars and Planets

Ray Jayawardhana, ISBN 0-7398-2212-8.

Life in Outer Space: The Search for Extraterrestrials

Kim McDonald, ISBN 0-7398-2213-6.

Secrets of the Sun: A Closer Look at Our Star

Patricia Barnes-Svarney, ISBN 0-7398-2214-4.

▶ While these books are aimed at middle-school children, any beginner would find them a useful introduction to their subjects. Each title gives an overview in easy-to-grasp language, mostly without talking down to neophytes. For anyone who is rusty at basic astronomy, these books provide a refresher course.

For example, in *Signals From Space: The Chandra X-Ray Observatory*, *Mercury* magazine editor Naeye explains how and why scientists hit upon the idea that x rays could answer questions yet unasked. Naeye outlines the history of x-ray discovery and use as he describes how astronomers developed advanced techniques for x-ray observing. Readers are left with a solid understanding of this technology and the kind of information that it promises to deliver.

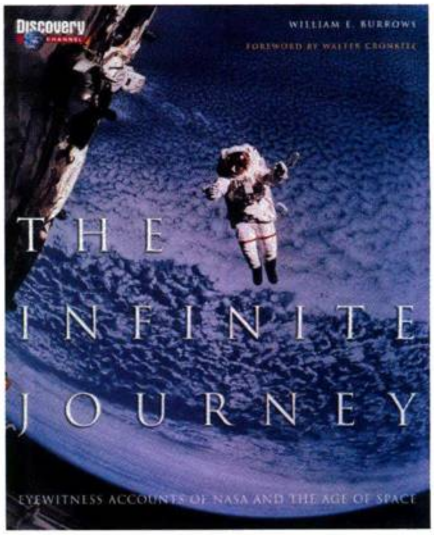
Likewise, in *Star Factories: The Birth of Stars and Planets*, Jayawardhana, an astronomer at the University of California at Berkeley, takes us from the beginning of documented celestial observations to recent discoveries of stellar nurseries and planetary systems outside the solar system.

Part of what makes this book intriguing is that the author is one of those scientists involved in extrasolar research. He helped find evidence that stars and planets form from interstellar dust clouds.

Of course, once we know of other planets, we naturally wonder if they harbor life. Kim McDonald, a science writer, explores how astronomers are doing on this quest in his *Life in Outer Space: The Search for Extraterrestrials*. McDonald not only details the studies and discoveries of odd habitats for life on Earth, but also explains the scientific imperative to look for life-forms where we might least expect to find them in the universe.

Since most forms of life on Earth depend directly or indirectly on the sun, Patricia Barnes-Svarney's *Secrets of the Sun: A Closer Look at Our Star* examines recent solar discoveries. As the SOHO and TRACE satellites collect visible light from the sun, ground-based telescopes and imaging techniques allow astronomers to study solar phenomena like never before. Barnes-Svarney, a freelance science writer, describes why it's important to detect coronal mass ejections and measure the solar wind in order to predict their effects on everyday life.

Each of the books in this fascinating series is superbly illustrated with photos, diagrams, and tables that explain complex astronomical theories. Each also includes a short glossary and suggestions for further reading. While most beginners will find these quick reads, most veterans will likely find interesting new tidbits about astronomy. — *Carol Ryback, associate editor*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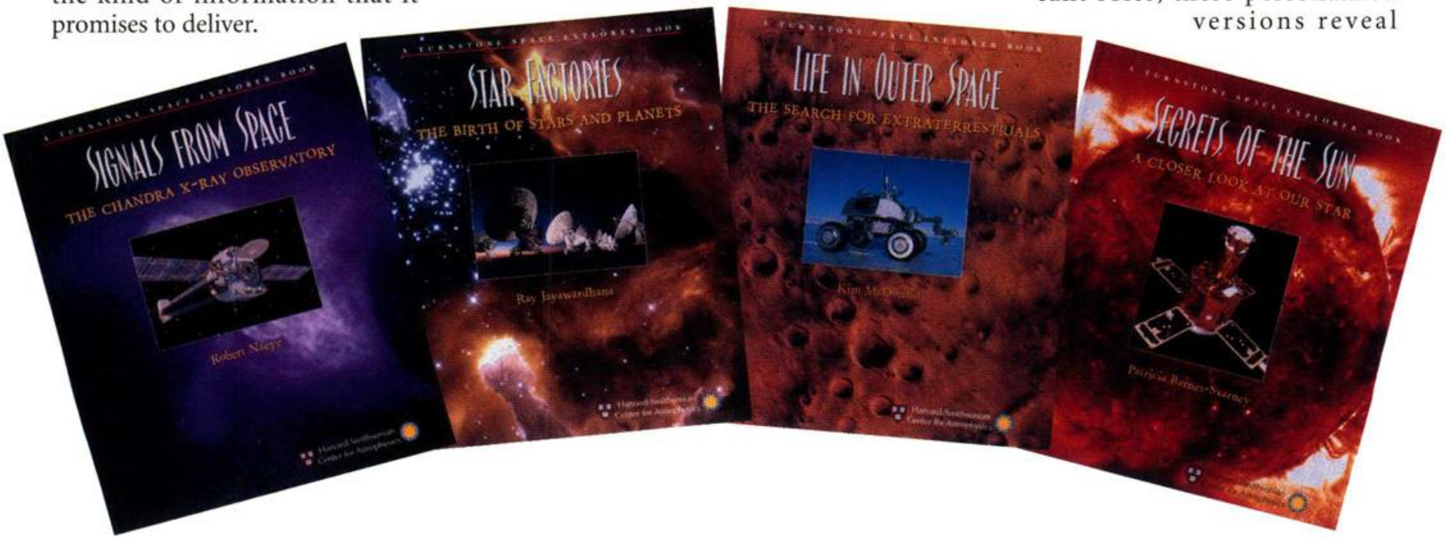
EYEWITNESS ACCOUNTS OF NASA AND THE AGE OF SPACE

The Infinite Journey: Eyewitness Accounts of NASA and the Age of Space

William E. Burrows, 240 pages, Discovery Books, New York, 2000; ISBN 1-56331-924-1, hardcover, $40.

▶ This coffee-table book contains historical vignettes of 30 of NASA's space endeavors from the late 1950s to the present. Written by eyewitnesses (famous and not) who played significant roles, these personalized versions reveal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much about NASA's exploits. What makes *The Infinite Journey* so compelling is the sincere expression of feelings by those involved in this quest.

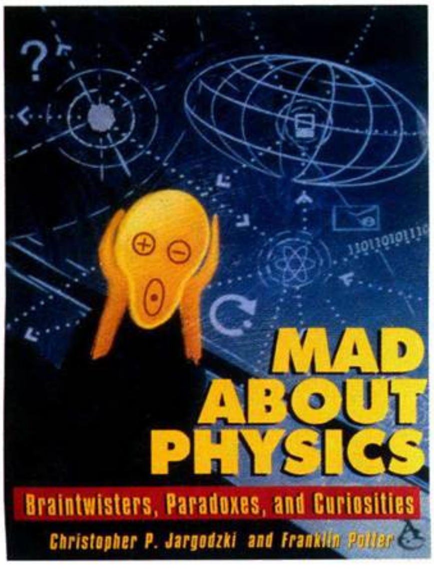
As I turned the glossy pages, I felt privy to the thoughts and offhand, candid impressions of the participants. It was akin to bumping into these people at a party as they swapped stories with one another — people who really didn't mind that I was listening in. You really don't have to follow any plan for reading this collection of observations. You can flit from anecdote to anecdote or decade to decade as the huge variety of pictures and scenes catches your eye. This is truly a book to dream over. — *C. R.*

Mad About Physics: Braintwisters, Paradoxes, and Curiosities

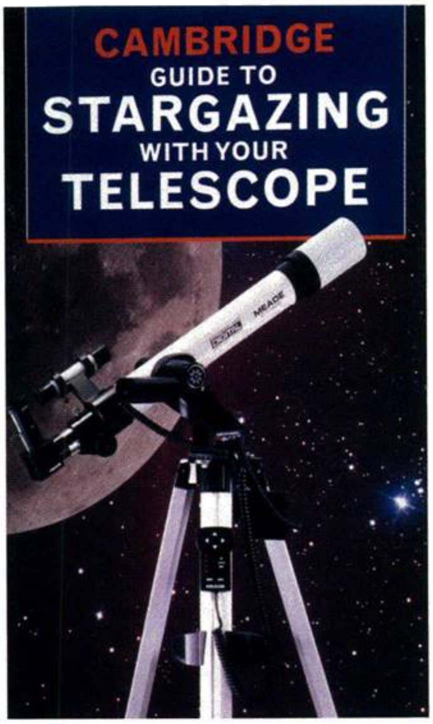
Christopher P. Jargodzki and Franklin Potter, 304 pages, John Wiley & Sons, New York, 2000; ISBN 0-471-56961-5, hardcover, $16.95.

▶ Here's a quick fix for those brainteasing inquiries that stick in your mind like an old song. While not limited to astronomy-related trivia, *Mad About Physics* — like a top-40 countdown on the radio — has an allure that makes you want more.

For instance, as you ponder where to aim your laser communicator in order to contact a space station (question number 46), you'll get stopped along the way (to the answer at the back of the book) by thinking about whether a motionless astronaut on that space station can control his or her orientation (question number 317). And before you answer number 46, it's likely that you'll also run across another reason the United States won the race to the moon (question number 375).


MAD ABOUT PHYSICS
Braintwisters, Paradoxes, and Curiosities
Christopher P. Jargodzki and Franklin Potter

This book is fun. It not only offers a challenge by reawakening childhood curiosities, but also provides answers to undo frustrations. You'll learn some physics, too. Better yet, you'll remember it because of how it was presented in this interesting book. — *C. R.*



Cambridge Guide to Stargazing with Your Telescope

Robin Scagell, 160 pages, Cambridge University Press, New York, 2000; ISBN 0-521-78448-4, hardcover, $14.95.

▶ Robin Scagell's pocket-sized handbook is perfect for beginners. The friendly narrative offers a commonsense introduction to astronomy. Scagell assumes the reader has no prior knowledge of astronomy, yet the text never makes the reader feel ignorant. Instead, I found that I wanted to keep reading. The author's usage of detailed descriptions helps form a bond of trust with the reader.

Begin reading this stargazing guide just inside the front cover and continue straight through to the end. Scagell starts with a star party where the reader meets amateur astronomers of many skill levels. The author explains why experienced observers choose the telescopes they do. This helps readers decide which telescope is right for them. This book includes tips about equipment that beginners might otherwise never think about. It advises beginners to consider the practical aspects of hauling a telescope around and not to neglect the size, weight, and ease of use of any piece of equipment.

You'll want to keep this guide nearby while setting up your telescope, finding astronomical objects, and observing them. It will take you from easy-to-find celestial objects to wonders of deep-sky observing. When you're ready to accessorize your telescope, make sure to consult this guide again. Even if you never add to your basic equipment, the chapter on using sky maps will help you get the most out of your scope. Scagell's book is a useful guide to enjoying a newfound passion. — *C. R.*

Turn Right at Orion: Travels through the Cosmos

Mitchell Begelman, 264 pages, Perseus Publishing/Helix Books, Cambridge, MA, 2000; ISBN 0-7382-0207-X; hardcover, $25.

▶ Ironically, in *Turn Right at Orion: Travels Through the Cosmos*, astronomy professor and researcher Mitchell Begelman takes readers on what turns into an almost introspective journey through outer space. This book targets those who want to ponder the Zen of the universe while contemplating Begelman's poetic explanations of physics. His artistic descriptions of scientific conjecture on the universe offer a fresh perspective that blends philosophy with fact. If you enjoy thinking about the cosmos at a spiritual level, *Turn Right at Orion* is for you: Everybody else, turn left. — *C. R.*

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The adventure continues in Chena Hot Springs, 60 miles from Fairbanks, and far from light pollution. The evening aurora should produce an impressive show as solar activity is expected to be high in March 2001. During the day, you can take advantage of cross-country skiing, snow shoeing, and ice-skating. Or relax in the world-famous hot springs.

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MEDIA

Brain in a Box: The Science Fiction Collection

▶ It's déjà vu with a retro sci-fi beat. Rhino Records has released a five-CD set of vintage TV and movie theme music, pop tunes, and lounge music. Some of the songs are so old they're new. Remember the "Martian Hop" by the Ran-Dells, or "Radar Blues" by Chris Conner? The B-52s describe "Planet Claire" as a place where . . . *All the trees are red. No one ever dies there. No one has a heeeeead…*

It's one thing to recognize the theme song of "The Rocky Horror Picture Show," but quite another to plug the five CDs into your vehicle's stereo system and listen to 113 tracks during a night of observing.

Rhino Records, 10635 Santa Monica Boulevard, Los Angeles, CA 90025-4900; phone, (310) 441-6628; fax, (310) 441-6575; website, http://www.rhino.com. $99.98.

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▶ You can explore the solar system with your PC thanks to a new "infotainment" multimedia program endorsed by Arthur C. Clarke, author of *2001: A Space Odyssey*. The six-CD set titled "Exploring the Planets" includes scientifically accurate interactive mission simulators, close-up views of planets as you orbit them, 360° panoramas of planet surfaces, and interactive briefings of space missions.

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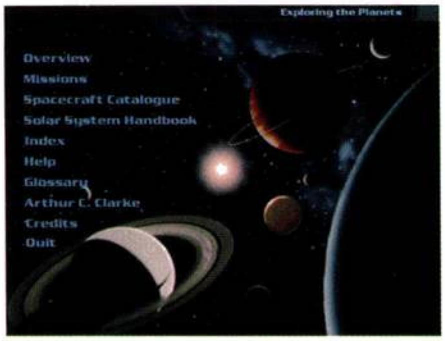
Kipany Productions, P.O. Box 940, New York, NY 10156; phone, (800) 554-9915; website, http://www.exploringtheplanets.net. $74.99. ▣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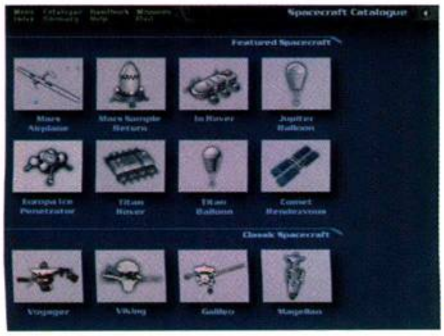
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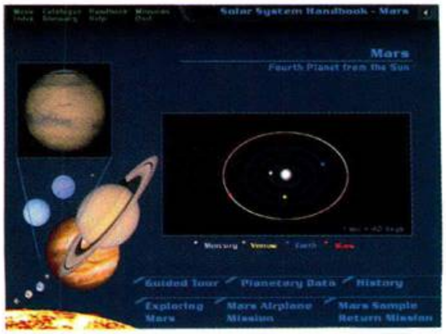
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The Webweaver Picks

Extrasolar Planets Unveiled
Australian astronomers recently discovered three extrasolar planets, and created a website that clearly explains their findings.
http://www.aao.gov.au/local/www/cgt/cgthome/staging.html

Project Mercury
It's been 40 years since Alan Shepard became the first American in space, and NASA has preserved the highlights of Project Mercury in words and images.
http://www.ksc.nasa.gov/history/mercury/mercury.html

Virtual Trips
Ever wonder what it looks like to circle a black hole? The movies at this site give you some idea of what it's like, and there are no nasty gravitational side effects.
http://antwrp.gsfc.nasa.gov/htmltest/rjn_bht.html

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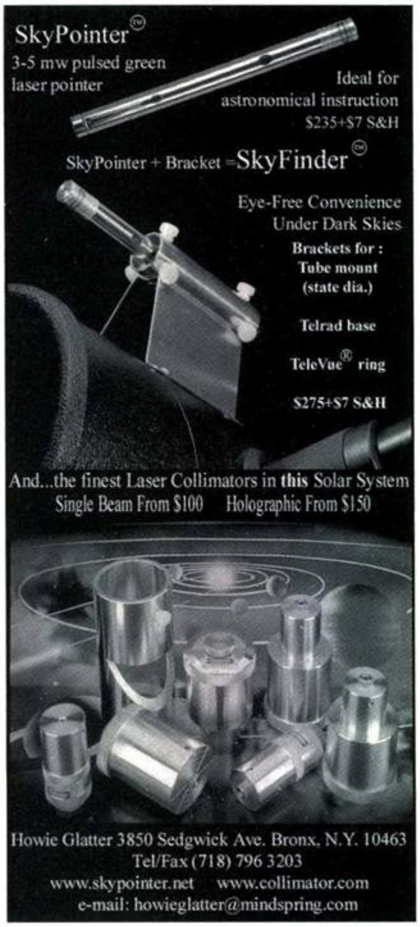

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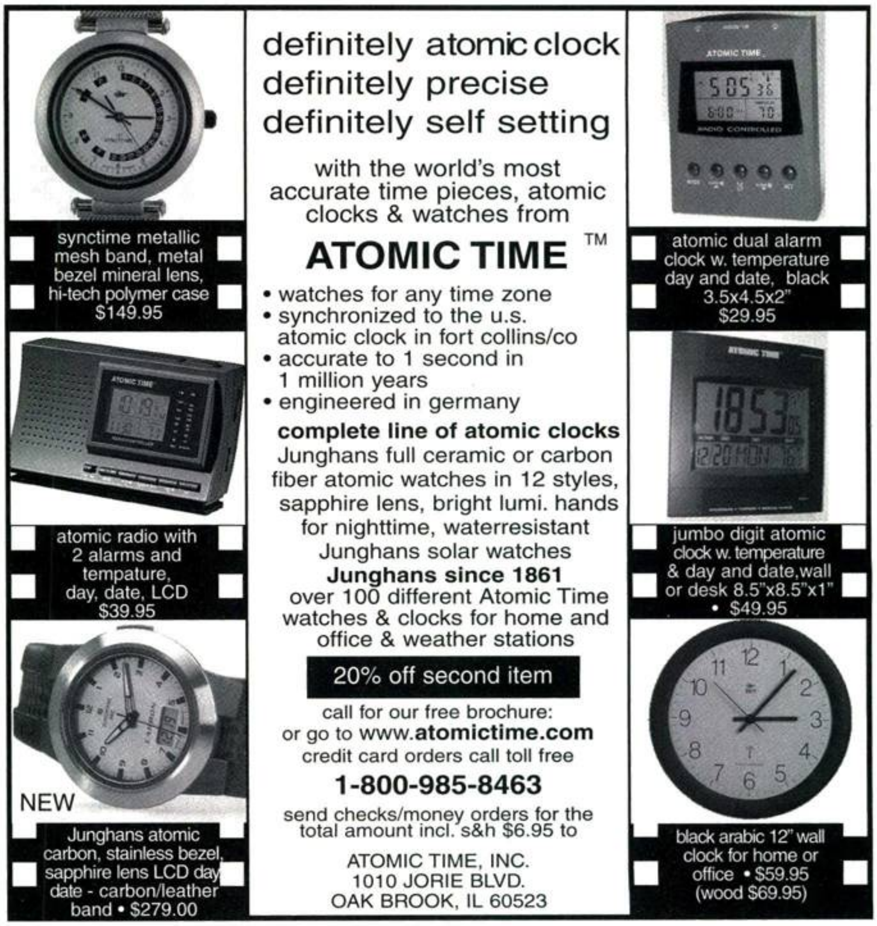

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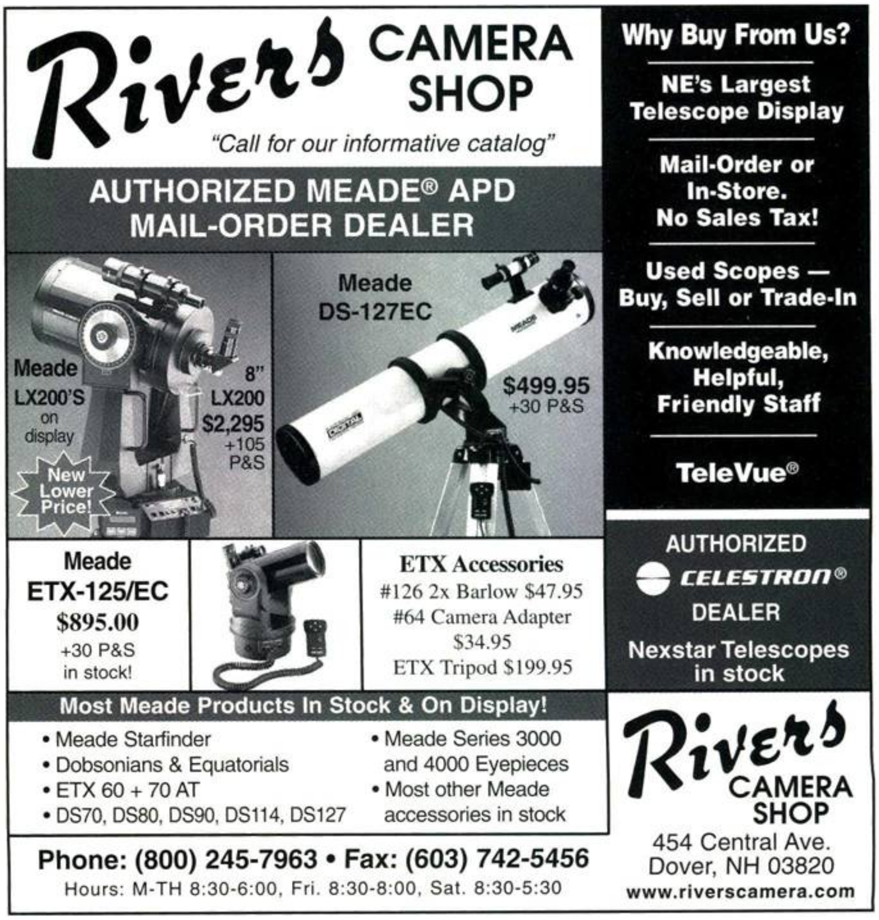

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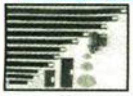

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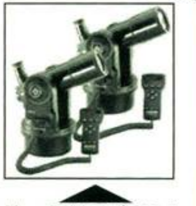

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Mention Ad A-7

The Texas Hill Country is the setting for the **Spring Central Texas Star Party**, to be conducted **April 20–22** at the new Eagle Eye Observatory and the Austin Astronomical Society's observing field located in Canyon of the Eagles Nature Park. The 940-acre park is located about an hour and a half from Austin, just northwest of Burnet, Texas.

The Eagle Eye is one of few observatories in the country that promotes a quality stargazing atmosphere to the public and has lodging available. View the stars from the building itself, home to a 16-inch Cassegrain telescope and a 14 1/2-inch scope, chart the skies from an observing field with your own equipment, or relax in the "Observing Salon" in the comforts of a hammock. The site offers exceptionally dark skies.

Daytime activities include hiking, swimming, boating, golfing, birdwatching, or fishing. The Vanishing Texas River Cruise can take you along the historic Colorado River to view spectacular waterfalls, sheer cliffs, spring wildflowers, and, if you're lucky, one of the bald eagles that give the park its name.

Lodging at the park includes rooms, RV sites, and campsites. For park information and reservations, phone (800) 977–0081 or view their website at http://www.canyonoftheeagles.com. For more information, contact the Austin Astronomical Society, P. O. Box 12831, Austin, TX 78711-2831; (512) 252–2966; website, http://www.main.org/aas/activity.html#centex; or contact Anne Adkins, (512) 451–8895; e-mail, anne@hadkins.com.

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This conjunction was captured over Calhoun Lake, Minnesota. Randall Wehler

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APRIL 11

ASME's Distinguished Lecture Series — The Chandra X-Ray Observatory

Tanner-Paull Banquet Hall, West Allis, Wisconsin. Jon Kriegel, a member of the Chandra design team, will speak about the technological advances made during the creation of the space observatory. Sponsored by the Milwaukee Section of the American Society of Mechanical Engineers. For more information, contact Ron Perez, (414) 229–6543; e-mail, perez@uwm.edu.

APRIL 18–21

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Rainwater Observatory, French Camp, Mississippi. For more information, call (662) 547–6865; e-mail, rainwater@astronomers.org; website, http://www.rainwater.astronomers.org.

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APRIL 28

Astronomy Day Celebration

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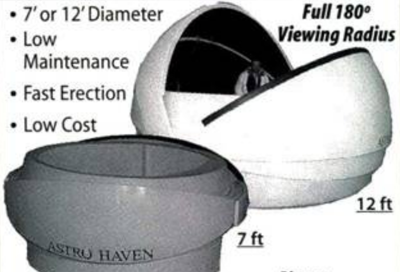

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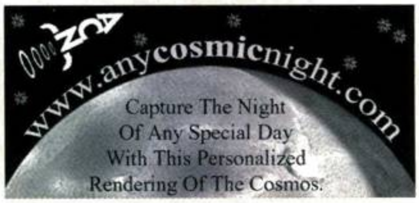

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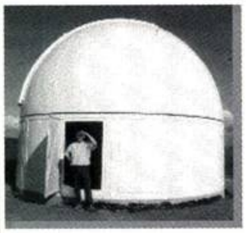

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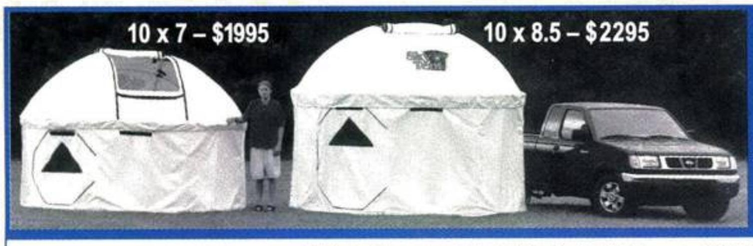

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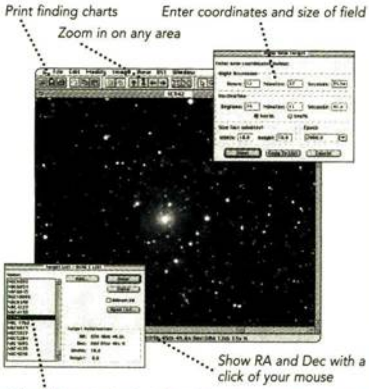
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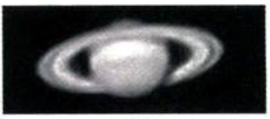

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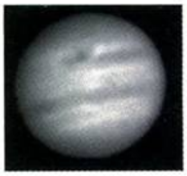

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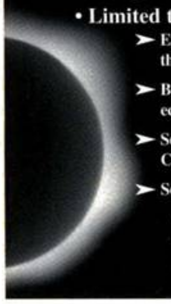

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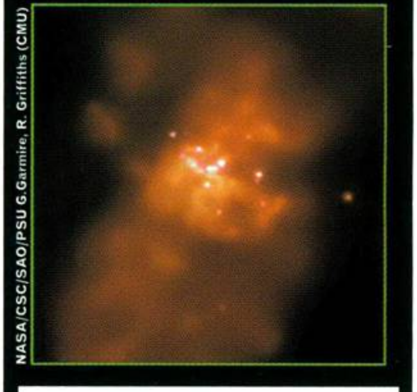

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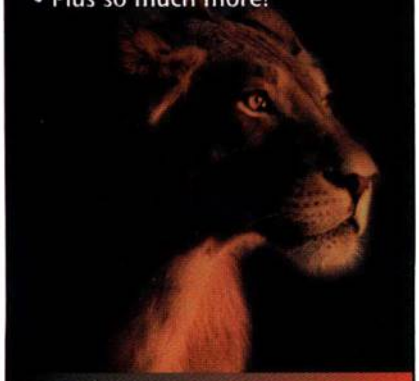

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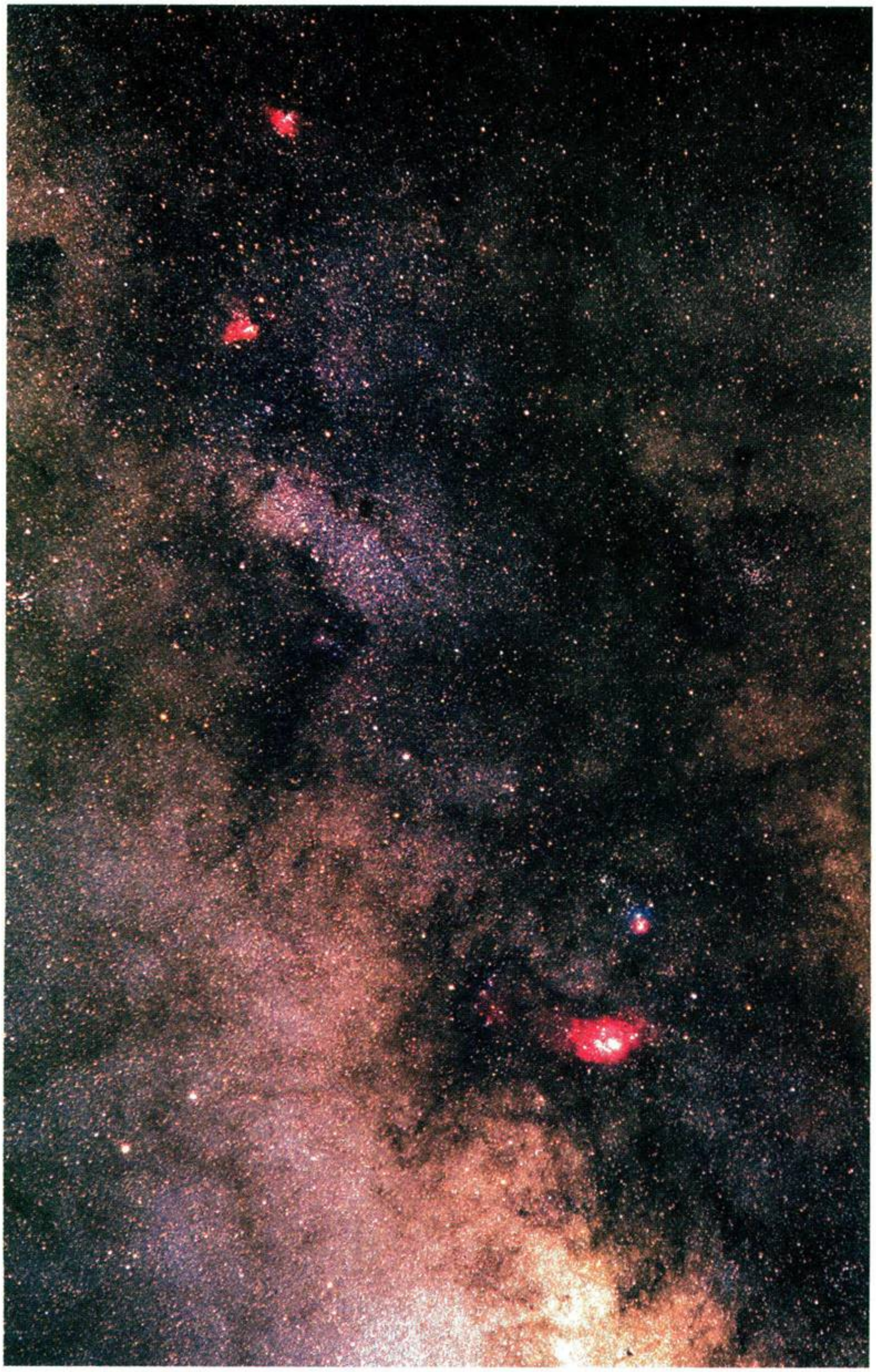
Deep-Sky Treats from Southern Africa

Dark skies and a remote location combined for a dream astroimaging trip.

▶ The center of the Milky Way loomed above in the darkest sky I had ever seen. I adjusted the music to be a little louder, turning the dials of my telescope too to capture a Southern Hemisphere treat. Though I spend a great amount of time under a black sky as a planetarium technician in Germany, this sky was remarkably different than the glowing dots I often see. It was August 2000, and I found myself in Namibia in search of the best skies I could find.

A former German colony until Britain took it over in 1915, Namibia is a lovely place with very few problems. Some years ago the noted German astrophotographer Bernd Koch traveled to the country and left an 11-inch SCT in place after he used it to make sensational images of Southern Milky Way objects. In 1996 I went there and shot some wild images. Last year a friend shipped his 16-inch astrograph to the same farm where Koch's SCT is set up. Suddenly, this little community in remote Namibia was becoming a colony for wayward astroimagers.

As I arrived in August 2000, the skies were somewhat cloudy. Two days and nights passed before I could roll out the film, load my 6x7



Summer Milky Way Splendors from Namibia

BRUNO MATTERN

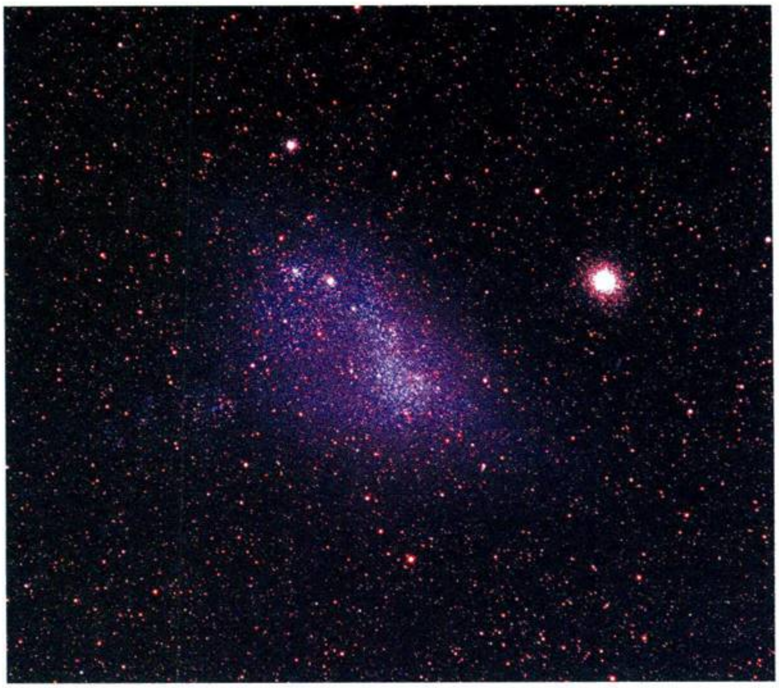
(105mm lens, 6x7cm camera, Fuji NGH II film, 90-minute exposure) cm camera, and start shooting. I mounted my camera on the astrograph and used an ST-4 camera as an autoguider. A friend brought a 5.5-inch SCT with him. After a delicious dinner on the third night, we marched off into the darkness and got the scopes operating.

After an hour it was dark enough to start imaging, and the Milky Way was arched overhead with its most brilliant part at the zenith. Dark nebulae popped out of the glow just as they normally appear on photographs. The absolute darkness was indescribable. The Magellanic Clouds were rotating slowly higher and higher during the night. We walked around the farm without red LED flashlights; our eyes were so dark-adapted we could see without them. Set up beside our photographic telescopes was a 20-inch Dobsonian for visual observing. We were absolutely stunned by the Tarantula Nebula (NGC 2070). For long stretches, we sat in the dark looking skyward, listening to the singing of the distant farm workers.

During the day, little time was left because we spent periods developing film and preparing the telescopes for the night to come. The view from 200 feet up was very satisfying.

We promised to return within the next two years. The next morning, we hitched a ride to the airport, passing rhinos and elephants on the way. It was a complete connection with nature — a time we won't soon forget. ■

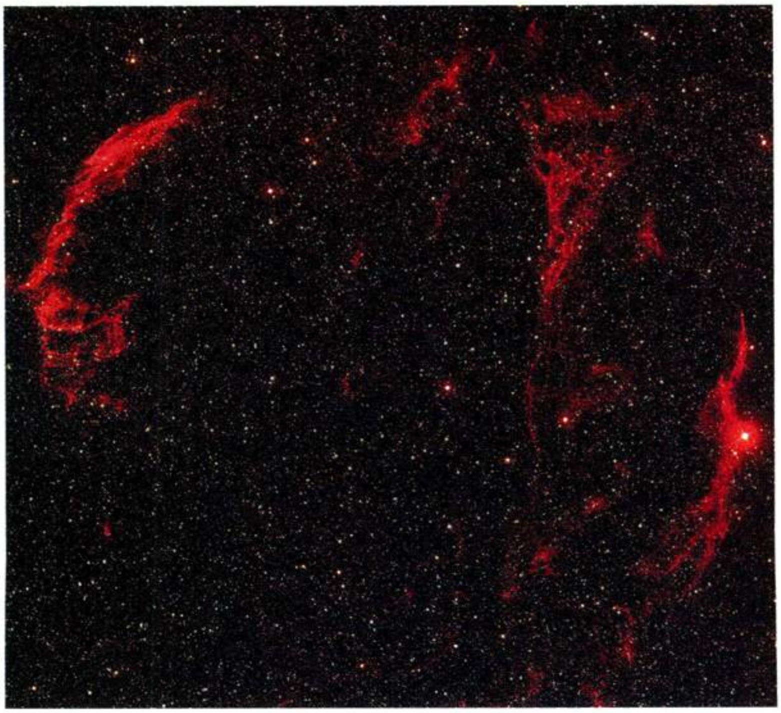
Bruno Mattern is an avid astrophotographer living in Hamburg, Germany.



The Small Magellanic Cloud and 47 Tucanae

BRUNO MATTERN

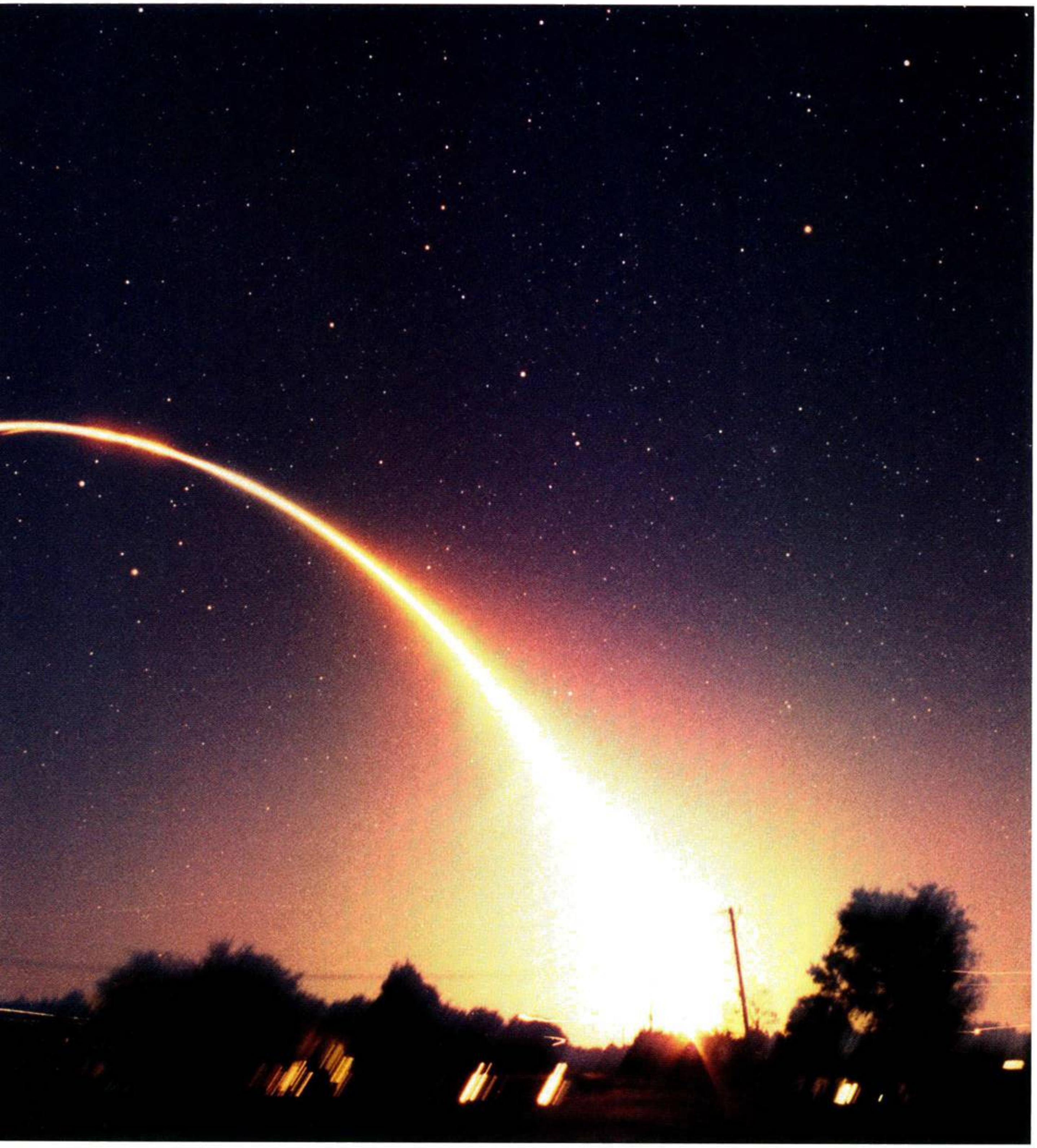
(200mm lens, 6x7cm camera, Fuji NGH II film, 90-minute exposure)



The Veil Nebula (NGC 6960, NGC 6992–5) in Cygnus

JASON WARE

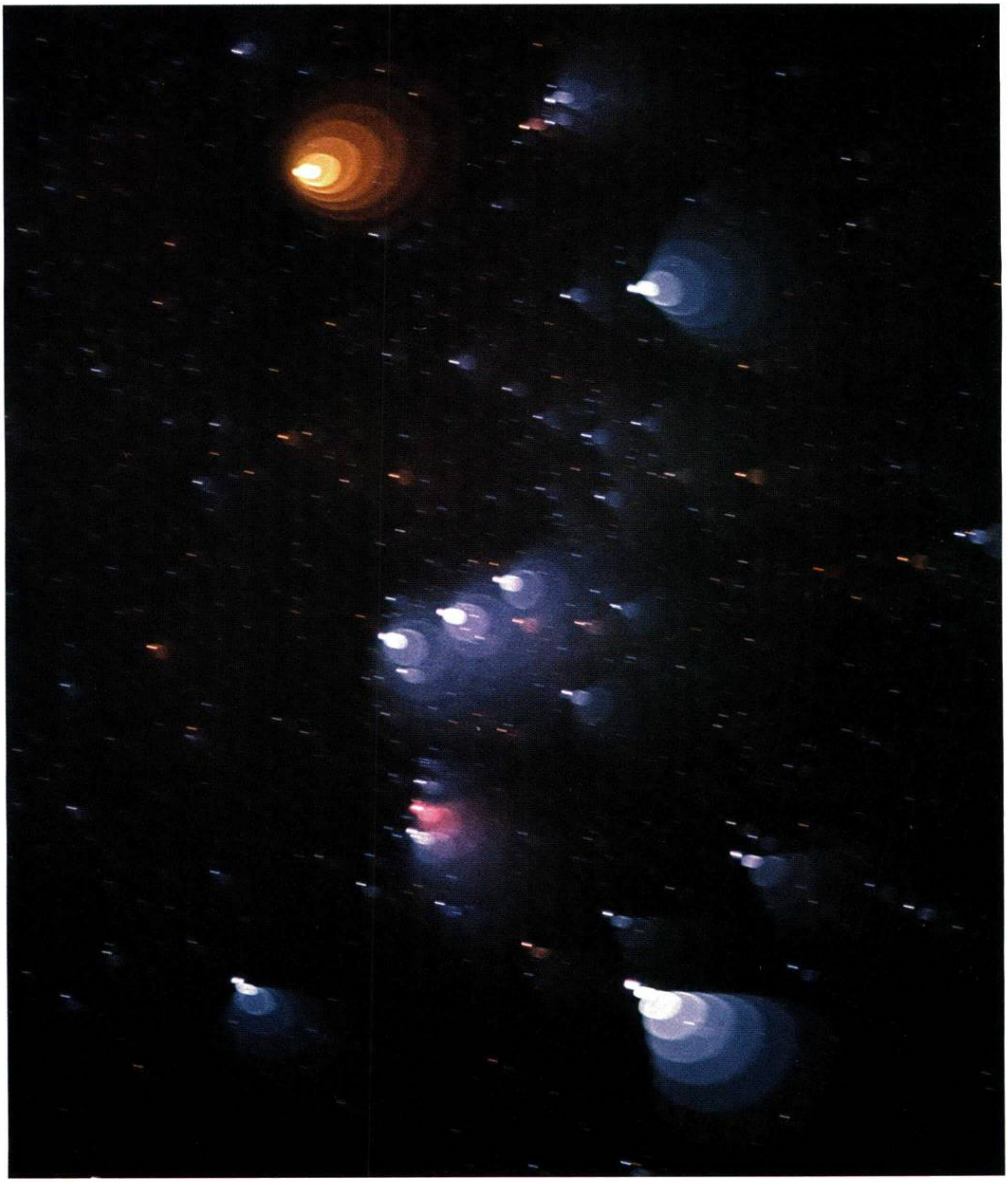
(12-inch f/2.2 Schmidt camera, Fuji 100 film, 120 format, composite of two 15-minute exposures made with a #92 red filter)



Space Shuttle *Endeavour* Launches across the Stars of Gemini

JEFFREY PETTIT

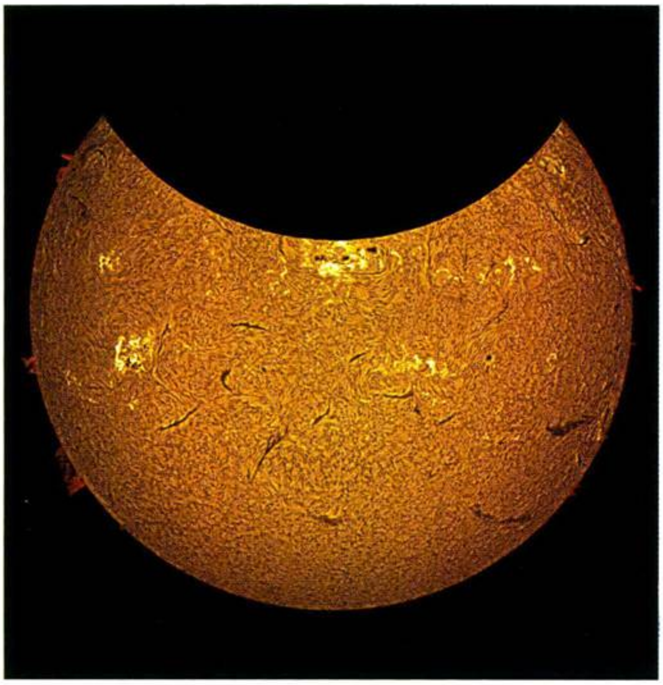
(24mm lens, 10-minute exposure taken November 30, 2000, from Sanford, Florida)



Orion the Hunter in Vivid Color

AMIRREZA ASGARY SHEMIRANG

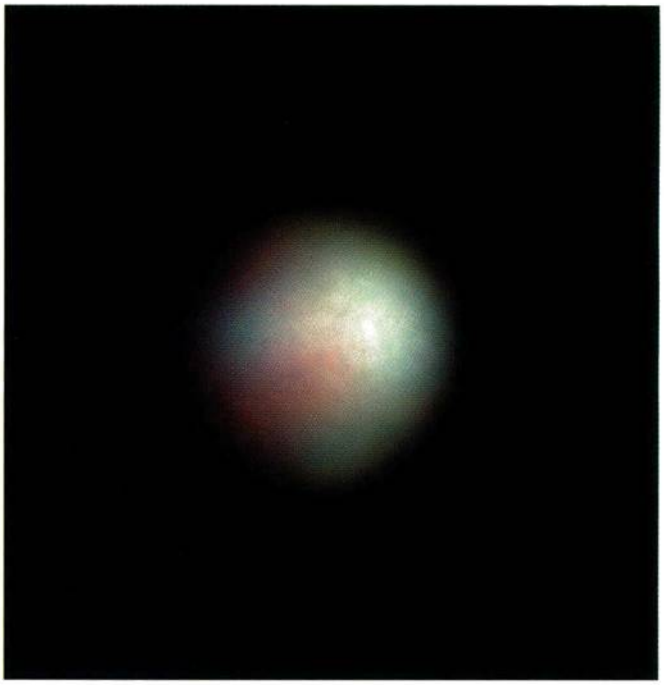
(By defocusing the camera's lens over regular intervals, a colorful portrait of stars emerges; a series of 7-minute exposures made from Tafresh, Iran)



The Christmas Eclipse Comes Alive

JACK NEWTON

(5-inch apochromatic refractor at f/25, H-alpha filter, 1616 XTE CCD camera, taken December 25, 2000)



The Red Planet Grows Toward Opposition

DON PARKER

(16-inch f/6 reflector at f/55, Lynxx CCD camera, composite image taken December 28, 2000)

Bright Aurora Illuminates Alberta

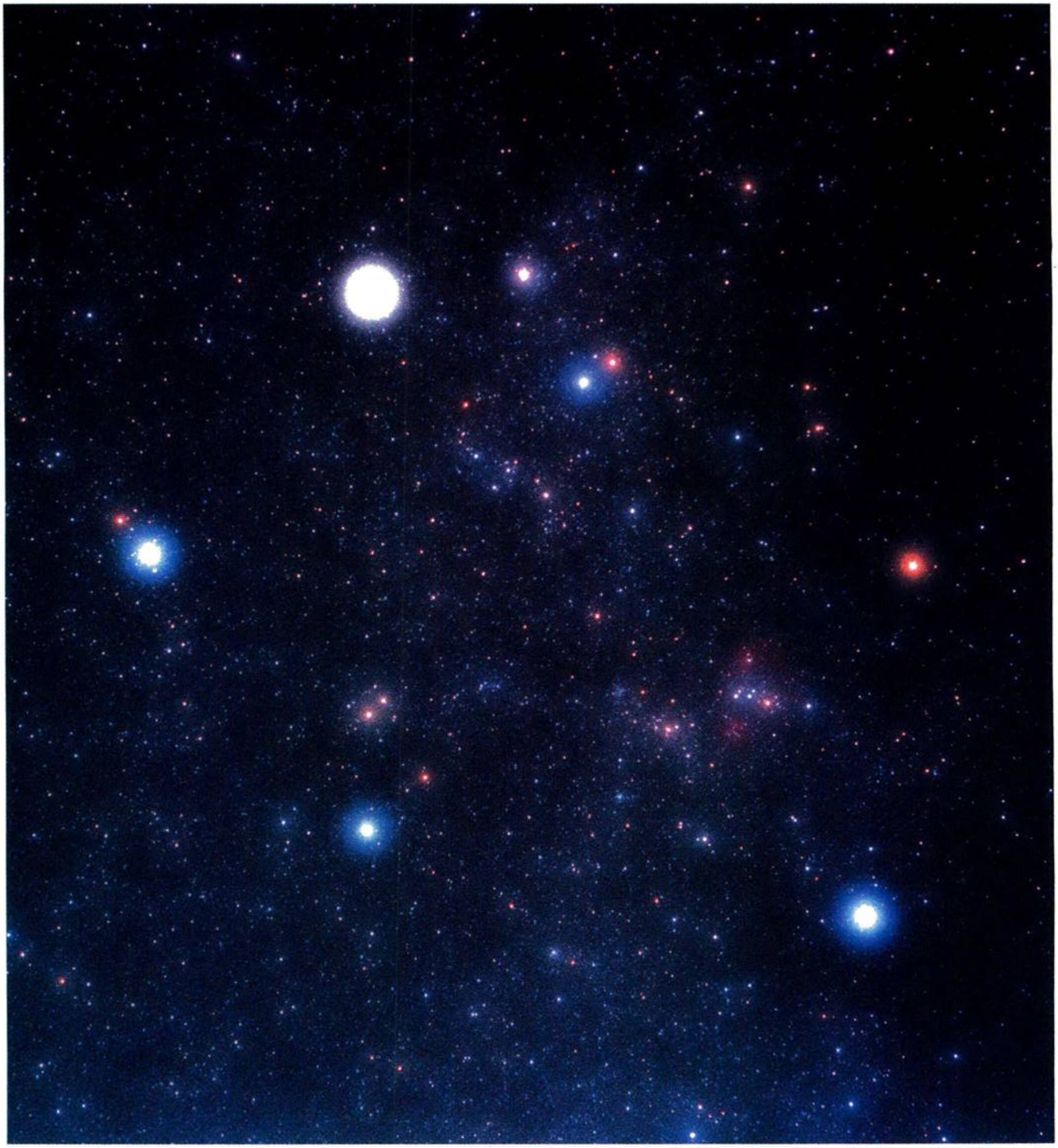
NORMA CHAMBERS

(16mm lens at f/2.8, Kodak Portra 800 film, 35-second exposure taken October 28, 2000)

Spiral Galaxy M81 in Ursa Major

ROB GENDLER

(12.5-inch Ritchey Chrétien scope, SBIG ST-8 CCD camera, composite exposure)



Auriga the Charioteer

GIANNI TUMINO, MELANIA PLUCHINOTTA, AND JEAN MARC LECHOPIER

(50mm lens at f/1.7, Kodak Ektachrome 200 film, composite of 10- and 20-minute exposures made with a diffusing lens)

Visible in this striking image are not only the bright stars Capella and Menkalinan, but ruddy clouds of nebulosity and the star clusters M36, M37, and M38.

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Horsehead Nebula region taken by Marco Lorenzi with an R200SS reflector with coma corrector.

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* Patent pending.

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